S. A. E. JOURNAL

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W. R. Strickland, *President* Coker F. Clarkson, *Secretary* C. B. Whittelsey, *Treasurer*

Vol. XXIV February, 1929 No. 2

CONTENTS

The purpose of meetings of the Society is largely to provide a forum for the presentation of straightforward and frank discussion. Discussion of this kind is encouraged. However, owing to the nature of the Society as an organization, it cannot be responsible for statements or opinions advanced in papers or in discussions at its meetings. The Constitution of the Society has long contained a provision to this effect.

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Will Rogers at the Annual Dinner

GET down! Sit down! You will tip your bottles over if you stand up. A gentleman just came in back here and said, "Will, we are ready to go. You can go ahead with your speech."

You people who have been coming to banquets for years in this wonderful hotel know that the Waldorf is going to be torn down, to make way for—well, Chrysler got this, too. He is going to combine it with something, I don't know what, keeping the best features of both. By the way, Chrysler is going to build a 58-story building and is going to take quarters on the top floor. He is going to get as far away from industry as he can.

Now, folks, I am awful glad to be here with you, because it is just as Mr. Kettering says, this is the great end of your industry. I have spoken at the Automobile Chamber of Commerce—that's a kind of high-hat outfit. A lot of my stuff—well, I wasn't good enough for them, you know. But I get down here with you all and I feel kind of at home because your mind is on your own work and not on the stock market. It is a pleasure to see somebody that looks like they are tending to their own business, and it is very unusual.

Now, it wouldn't be hardly appropriate for anybody to make a speech before an engineers' meeting if they didn't read a paper. From what I have read and found out about your Society, it practically thrives on papers and prepared articles. At every meeting or gathering they read papers until everybody is exhausted. The Society of Automotive Engineers and a billy goat are the only two things I know of that thrive on papers.

I have divided my little impromptu talk under the following heads: acceleration, methods to attain smoothness, piston-ring technique, steel-backed bearings, combustion-chamber designs, metric plugs, pistons, iron and aluminum—I may discuss them both—and intake and exhaust manifolds, stiffening of the crankcases, lubrication, then mechanical gasoline pumps and rubber mounting, high and moderate speeds, and do we need a reamer and how good are our air-strainers? I will bring all those last in under the heading of general remarks.

Under miscellaneous features, I will close with valves and cylinder design, oil temperature and all the rotating parts. Stationary parts will come under the heading of summing up. Now, that will give you a rough idea of what you are in for.

The first subject was acceleration. There is a thing that we have got to have. With no acceleration, this great gathering of men would not be accelerating. It is just little things like this that have created our great study of the valves of the squirt-gun type. So, boys, in laying out our sales campaign for '29, don't overlook acceleration, because that is going to be one of the big things.

Now, methods to obtain smoothness. I have looked that up in here and, after seeing a questionnaire sent out by the Buffalo Automobile Chamber of Commerce, I have come to some very definite conclusions. The questionnaire asked, Do you want smoothness in your engine? Out of a thousand letters sent out, five hundred reached their destination on account of having the right address. One hundred people had moved on account of dissatisfaction with the late election and was not there. The other hundred couldn't write.

My good little personal friend, Harvey Firestone, answered from Liberia in black ink that by now he had the Liberian senators and congress all house-broke, but every time they tapped a rubber tree, the rubber dropping down into the bucket bounced around, and they couldn't get hold of the rubber after they had grown it, and the Liberians grabbed it up and run the wrong way with it and took it to Goodyear's instead.

On the final analysis, 20 per cent of the people wrote back and said they wanted a smooth-running engine. The other 80 per cent said they wanted continuous performance. They said they didn't care whether the thing run smooth or rough, but for God's sake, keep it going. But in the entire questionnaire there was very little fault found in the engineering part of the car. Thirty per cent of the people said the clutch wouldn't work. Fifty-two per cent was not only dissatisfied with the engine but was absolutely disgusted with it. Seventeen per cent said the steering was all right if you could guess the same way it did. Sixteen per cent talked about the lights—said the thing runs better in the dark. They all gave the year of their cars but none of them would give the maker; they had that much consideration for the firm.

So this marvelous record in smoothness was all laid to torsional-vibration dampeners. That is one of the main things we have got to take up here. Pontiac was a pioneer in that, and, to offset that, why Raskob joined the Democrats. That was not only a blow to engineering but it was almost a catastrophe for the Democrats.

Wait, let me get back to my paper. I am like all of them; I don't know where I am at. If I did, it wouldn't be like reading a regular paper. We will eliminate the vibration dampener and square-bored or stroke ratio of engines with a fair-sized crankshaft. What we need is a bull market and a quicker turnover. Every time just a medium turnover occurs, you only can sell perhaps a new fender and some new glass. A fair turnover is one where practically both fenders were busted and a wheel. maybe broke. But what you would call a real good turnover is a front somersault. That means a new car. If you engineers had built the things right in the first place, you would never have had these turnovers, and a lot of you would have been working for a living today somewhere.

That brings us down to the piston-ring technique. I read through the papers here, and I find that Ralph Teetor was the first engineer to find out that the piston-ring wasn't working. The general public had found it out a long time before, but he was the first engineer to learn it, and, being only an engineer, why, of course, it took him a little longer to find it out. But he found out that at a certain critical speed, a blow-by jumps up at a terrific rate. Chrysler has used these tongue-tight rings on pretty near all the companies that he has been able to take over. Of course, the ones he has bought this week, they haven't put that tongue-tight ring in there yet. Tongue-tight is a Latin word and comes from the word Calvin.

So, narrow piston-rings and more of

Meetings Calendar

1929			FEBRUARY			1929
SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
					1	2
3	4	5	6 MILWAUKEE	7	8 SOUTHERN CALIFORNIA	9
10	11 CLEVELAND DETROIT	12	13 NEW ENGLAND	14 INDIANA METROPOLITAN (NORTHERN CALIFORNIA)	15	16 NORTHWEST
17	18	19 BUFFALO PENNSYLVANIA DAYTON	20	21	22	23
24	25 DETROIT	26	27 WASHINGTON	28		

Buffalo Section Meeting—Feb. 19
Automotive Tappet-Exhaust-Valve Design—Richard E. Bissell and Gordon T. Williams, Thompson Products Co., Inc.

Canadian Section Meeting—Feb. 13

Cleveland Section Meeting—Feb. 11
Automobile Bodies—George Mercer, Consulting Engineer

Dayton Section Meeting—Feb. 19
Oil and Fuels—D. P. Barnard, 4th, Standard Oil Co. of Indiana

Detroit Section Meeting—Feb. 11
Combustion-Chamber Design—R. N. Janeway, Consulting Engineer, formerly with General Motors Corp. Research Laboratories and Dodge Brothers

Detroit Section Aeronautic Division Meeting—Feb. 25
Ladies' Night—Meeting followed by an informal dance. Music by Detroit "High Hats"
Foreign Aeronautics—William B. Stout, W. B. Stout Engineering & Finance Co.

Indiana Section Meeting—Feb. 14
Automobile Show Review

Metropolitan Section Meeting—Feb. 14
Joint Service Meeting with the Automotive Service Association

Milwaukee Section Meeting—Feb. 6
Diesel Engines

New England Section Meeting—Feb. 13
Carburetion with Special Consideration of Thermostatic Control—Merl R. Wolfard, Hopwell Brothers research laboratory

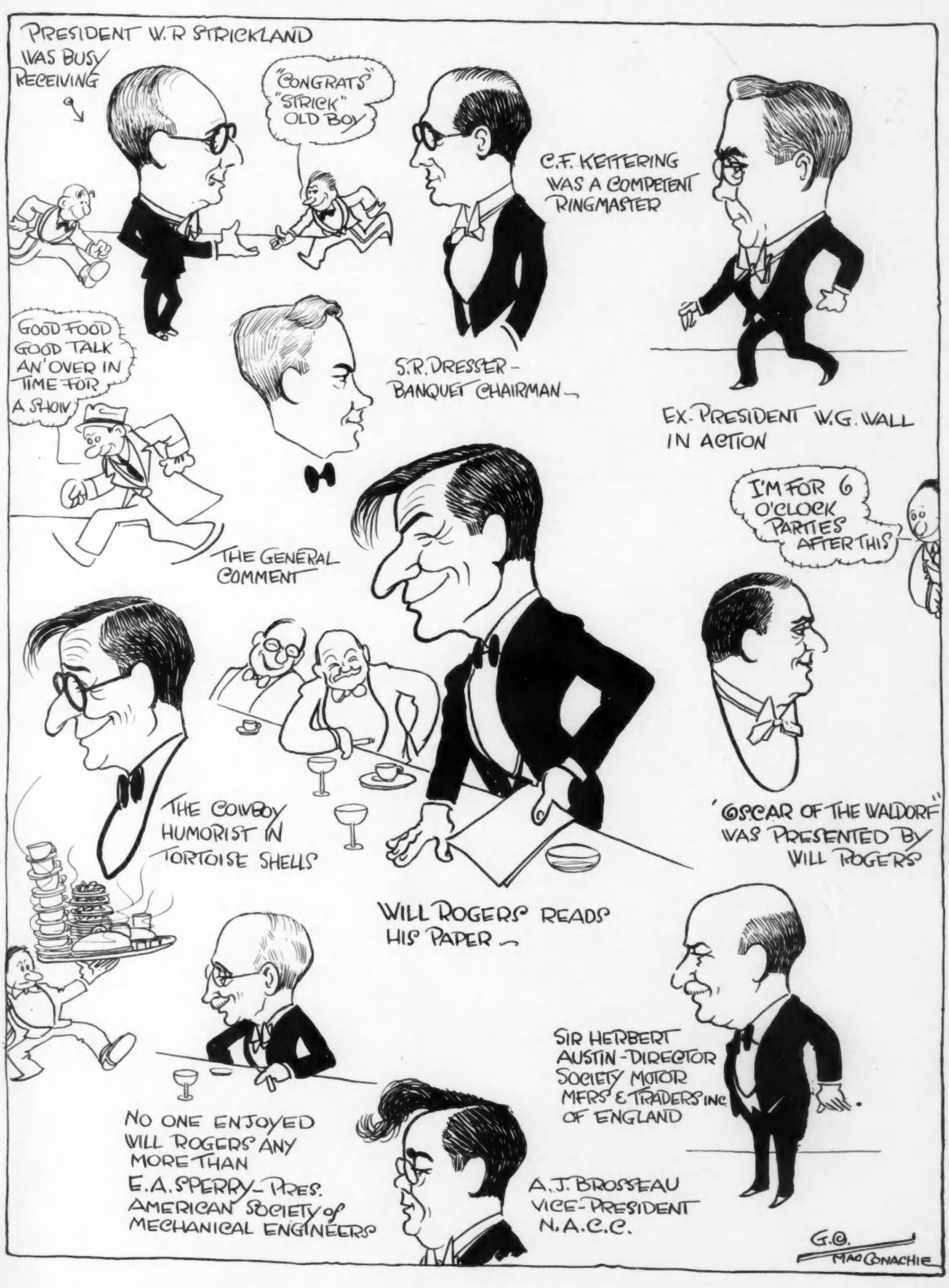
Northern California Section Meeting—Feb. 14
Body Forms of Automobiles and Airplanes—Perham Wahl, Assistant Professor of Drawing, University of California
Wind-Tunnel Tests of Automobile Fans—Vincent C. George, Assistant Professor of Mechanical Engineering, University of California
License-Plate Legibility—W. L. Ingraham, Graduate Student, University of California

Northwest Section Meeting—Feb. 16
Portland, Ore.
Motorcoach and Truck Tire Change-Over and Subsequent Problems—A. N. Day, Goodyear Tire & Rubber Co. of California

Pennsylvania Section Meeting—Feb. 19
Transportation Meeting
The Effect of Changes in Design upon Truck Operation—J. F. Winchester, Standard Oil Co. of New Jersey

Southern California Section Meeting—Feb. 8
Diesel Engines

Washington Section Meeting—Feb. 27
Aviation


PRESIDENT W.R STRICKLAND
WAS BUSY RECEIVING
"CONGRATS" "STRICK" OLD BOY
C.F. KETTERING WAS A COMPETENT RINGMASTER
GOOD FOOD GOOD TALK AN' OVER IN TIME FOR A SHOW
S.R. DRESSER - BANQUET CHAIRMAN -
EX-PRESIDENT W.G. WALL IN ACTION
I'M FOR 6 O'CLOCK PARTIES AFTER THIS
THE GENERAL COMMENT
THE COWBOY HUMORIST IN TORTOISE SHELLS
"OSCAR OF THE WALDORF" WAS PRESENTED BY WILL ROGERS
WILL ROGERS READS HIS PAPER -
SIR HERBERT AUSTIN - DIRECTOR SOCIETY MOTOR MFRS & TRADERS INC. OF ENGLAND
NO ONE ENJOYED WILL ROGERS ANY MORE THAN
E.A. SPERRY - PRES. AMERICAN SOCIETY of MECHANICAL ENGINEERS
A.J. BROSSEAU VICE-PRESIDENT N.A.C.C.
G.O. MacCONACHIE

them is the slogan of 1929. They don't cost much, and we might as well let the customer think he is getting a lot for his money, so give him a lot of rings. He is getting a lot of rings, but could do the same thing with a bell.

Well, by lapping instead of grinding, cylinders have become almost universal in production, which means more accurate bores, whether they be cylinder bores or just plain after-dinner speakers.

Now we get to the steel-backed bearings. That is the thing that really the industry is based on. They used to use bronze on them but on account of them being in the back where nobody would see them, they said, "We will just say they are made of steel and go ahead and put iron in there, and so the bonding of babbit and the steel is gaining great headway. It is not only the babbit in the bearings but the Babbitts in the small towns that keeps all you birds working and was directly responsible for Hoover going to South America on a battleship on a peace mission.

Now we get down to metric plugs. They have always been used any time the betting is five to one on compression. But the Hudson cylinder-head is one of the new ones. Does Roy Chapin still own the Hudson? The metric plugs and the cylinder-heads is two things we should adopt if we are ever to give the farmers relief enough to buy another car. The trouble with the farmer is he belongs to so many relief organizations that he is not raising his dues. We have got to do something about that. What he needs is to trade his speedometer for an alarm clock. That is his only salvation.

Now, the lubricating system—that will interest this gang. This has been giving us untold trouble since June 1, 1920. How much oil can you stand?—that is the main thing. You take a high-test oil and you won't get as far with it but you will have more fun while you are going. Joe Bijur taught the industry how to lubricate the chassis with one shot. If he gives his thoughts to human lubrication, he might make a one-shot drink out of everything.

Fred Moskovics was around here, wasn't he? He has a sun-dial on the radiator of the Stutz, and the thing won't run on cloudy days. No matter how many accidents you get into, the chassis will always come out all right. He calls it a safety chassis. So you can be in one of those automobiles, you know, and the engine can get wrecked and you can bust up the body and break your own body, but just so the chassis is saved, that is all he cares for.

That brings us down to air-strainers. That takes in Senators, Congressmen, salesmen and engineers. No air-strainer is any good; Borah and Jim Reed have been the greatest examples of that. The radio has proved that air should never be strained. They should leave it like it is in the first place. Sandy Brown discoursing on golf is another example that air should be let alone and not be messed with whatever. Even a rain in Quebec didn't stop you all when you were there last year.

I have been up to your show. You do have one distinguishing feature of your automobile show this year, and that is that you couldn't possibly get that many cars that looked alike together before. You know what I mean. But I certainly do want to pay my respects to Sir Herbert Austin. You can certainly find the one he brought over. I enjoyed your car very much, Sir Herbert. After the show and looking at all the cars, I hurried right back to the theater, and I was ten minutes brushing them out of my hair. But if you can just keep them out, they are wonderful, you know.

They tell me that 150 of you birds sent in a list of the kind of car you would make, and averaging up all the things you sent in, it turned out to be a Reo. I am not saying anything against a Reo, because I have driven one and they are good cars, but if that is the best that 150 of you collectively could build, well, individually you might be good engineers, but collectively you are terrible.

That gets me off on to the subject of Uncle Henry. Mr. Ford give me the first car. I was in Detroit to see him. He and I are old cronies. I owe the industry an easy living for all these years because Henry Ford was responsible for me doing the type of act I am doing today. I'll tell you how it was. He made this trip to Europe to stop the war, and we thought that was a funny idea, somebody trying to stop a war. Now we have a whole Nation here trying to sign a treaty to do the same thing that he was trying to do, only he was doing it in better faith than they are. We have a bill in Congress to make 16 new cruisers and another one to have universal peace, and they don't know which one to sign.

Mr. Ford made this trip and I had a lot of gags about it. Up to that time I had been doing my little roping act and had no talk. I came home one night, and my wife said, "How is the show going?" I said, "Not so good. I have been there five or six weeks now and we get the same crowd every night. My jokes about Ford ain't going so good." She said, "You read the papers all the time; why don't you talk about what you have read?"

Well, I found out that Congress was funnier every day in the year than Ford ever was. So now that is all I do; I just watch the Government and report the facts. If you do that, you have over 600 or 700 men in Washington working for you every day.

Mr. Ford and I have always been pretty good friends, and he said, "Will, I am going to give you a car." I went home all hopped up and excited. I thought maybe it would be a Lincoln. So he sent the car out, and I went down and opened the garage door, and here this thing crawled out. It was just an Austin with a necktie on. But I had the first one of those cars, and it is a great car, a wonderful little car.

The Ford and Charley Chaplin are the best known objects in the world. An Englishman knows a Ford car better than he does their national anthem right now. Chinamen know what a Ford is, and they don't even know where their next missionary is coming from. Mr. Ford is responsible for more dirty dishes being left in the sink at night than any man that ever lived. He used to have it in for the Jewish people until he saw them in Chevrolets, and then he said, "Boys, I am all wrong."

Your cars have everything in the world on them—wonderful engine, all kinds of appliances inside and out, and now, for God's sake, will you make a door that will shut without slamming? I am just going to ask you engineers why is it, when everybody gets in the car, then it is one person's business to open every door and jerk it to? I am giving you that as next year's problem. I want someone to come to next year's show with a door that you don't have to slam and that a fairly strong woman can open from the inside. You can take any sedan in the show and lock a frail woman in it and she will starve to death before she can get out. You couldn't open it in a million years. I see in your ads it tells how easy it is to roll the window up. But who is going to climb out of the window? Get the door so it will open and shut like any other door. That is my only problem that I have got to lay before the industry in a real serious way, but there is no comedy about that, and I want you all to take it up and do something on it.

Here is another thing; if I was making automobiles, I wouldn't tell how fast they would run. I would say, "Here is a car that stands well," because that is all they are doing. One half of the world is setting in a taxicab mostly waiting for a green light to come on. If we keep on looking at red and green lights, in two more generations our children will be born with one eye red and one green. Some of our taxicabs have put in cigarettes as a courtesy to their customers. Lord, they ought to put in a bed and some emergency rations.

I don't know what in the world we are going to do with the traffic problem. It is terrible here in New York. You say, "where are you spending the afternoon?" and the answer is "Between Fifth and Sixth Avenue. Look in all the cabs and you will see me."

Annual Meeting Well Received

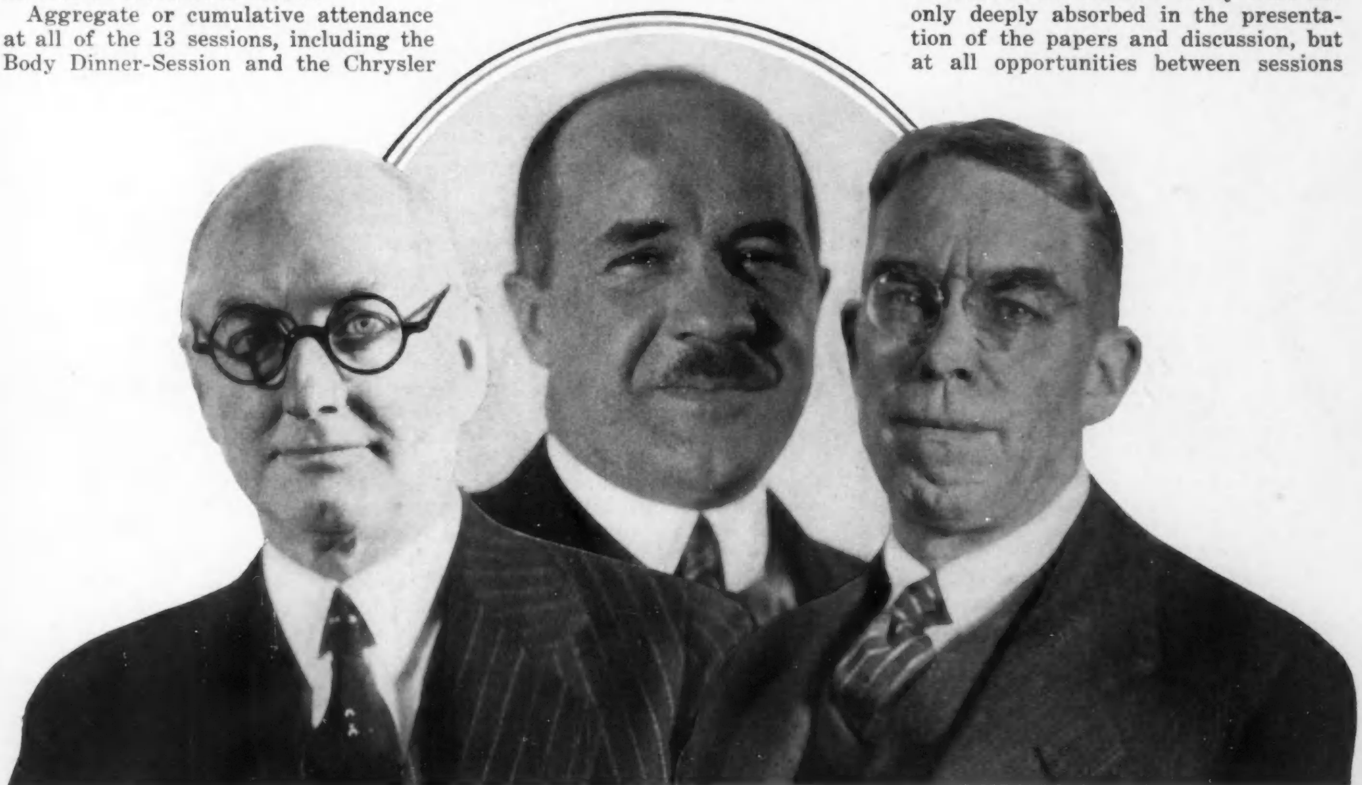
Larger Attendance, More Serious Interest Shown and Papers of Great Value on Wide Variety of Subjects Presented

AFTER-THE-MEETING views on this year's Annual Meeting are in agreement that, judged from all angles, it was the "best ever." One standard of comparison is attendance. Total registration at the 1929 meeting was 1134, as against 1049 at the 1928 meeting. The greatest attendance at any Annual Meeting prior to last year was 969, at the 1924 meeting, held in the General Motors Building. Growth of the Society in membership from approximately 5700 in 1924 to nearly 7000 in 1929 doubtless accounts for most of the increase in attendance, but other factors believed to have an important influence are the keen search that all branches of the industry are making to further improve automotive vehicles and their components, the up-to-the-hour developments reported in many of the papers presented, and the holding of the sessions in a commodious hotel in the heart of the city, where they are most accessible both to out-of-town attendants and to the largest number of resident members.

Aggregate or cumulative attendance at all of the 13 sessions, including the Body Dinner-Session and the Chrysler Engineering Laboratory Session, was 2935. Exclusive of the 735 at the Body Dinner and the 632 at the Laboratory Session, the average attendance at the technical sessions was very close to 150. It was noticeable that all of these sessions were rather uniformly attended, indicating that they were about equally attractive; also that the figures indicate that, on the average, only 40 per cent of the attendance at each session was composed of those who attended other sessions, that is, that members attended 1.4 sessions each. This is exclusive of the Body Dinner and the Laboratory Session, which drew three times the average attendance. The figures, and also observation, indicate that, although members were too busy to attend many sessions, they regarded two or three sessions as too important to them to be missed.

Seriously Seeking Information

Another phase of the meeting that was evident was the serious attention of those in attendance. They were not only deeply absorbed in the presentation of the papers and discussion, but at all opportunities between sessions



THE TRIUMVIRATE AT THE S.A.E. ANNUAL MEETING

President W. R. Strickland (Left), Who Assumed His Duties at the Close of the Annual Meeting; George L. McCain, Chairman of the Annual Meeting Committee, Responsible for the 1929 Annual Meeting, Which Brought Past-President Wall's (Right) Successful Administrative Year to a Fitting Climax

they were eagerly seeking information in private talks with the authors, discussers and other members. The members were obviously present to gather every scrap of engineering fact bearing on the problems of the time.

An extraordinarily large number—632—rode out to the Chrysler laboratory on Thursday night for the inspection of the establishment and for the technical session. As was to be expected, the Body Dinner in the ballroom of the Book-Cadillac on Wednesday night, sponsored by the Detroit Section Body Division, drew the largest crowd—735. This was the only social and entertainment event of the meeting arranged by the Society.

Accommodations and arrangements for the sessions were excellent, and the public-address equipment and new dissolving-view stereopticon that are now a part of the Society's meeting paraphernalia, markedly added to the interest in the proceedings as compared with meetings of previous years. Under the able direction of the various chairmen, every session was conducted with promptness and in a way to give satisfaction to all.

Too Much To Digest

If any criticism is to offered, it is that the Annual Meeting programs have become too full. Even four days, with three sessions per day, do not allow time for presentation of the large number of papers scheduled in a way that is satisfactory either to the authors or their hearers; and no subject can be exhaustively discussed in the limited time available when three or four papers on as many different topics, with prepared discussion on them, are scheduled at a single 2½ to 3-hr. session. Each speaker feels under pressure to hurry through his presentation, the lantern slides are run off too fast in some cases for their significance to be comprehended, and doubtless many who might have some worthwhile thoughts to express in extemporaneous discussion are discouraged from offering them.

The opinion has been expressed by a number that it would be better to confine each session to one general subject, with two or at most three papers on different phases of it, and allow more time for thorough discussion, as it always has been held that discussion is a prime feature of meetings.

Business and Committee Meetings

A great deal of activity at the Annual Meeting revolves about the Business Meeting, the Council sessions and meetings of various committees of the Society. At Detroit the Standards Committee met to act on reports submitted by its many Divisions, and these were subsequently placed before the members and acted upon by the Council prior to being submitted by letter-ballot to the voting members of the Society. Sessions were held at Detroit by the Research, the Meetings, the Sections, and the Publication Committees.

In the following news account of the Annual Meeting each session is reported separately, with a summary of each paper and the discussion on it; and all of the other activities are covered individually, the aggregate giving a comprehensive narrative of the proceedings which should be of great interest and value to those members who were unable to attend.

Fuel and Headlight Research

Three Papers on Gasoline and One on Second Phase of Headlighting Study Given

Fuel and headlight research reports stimulated a volley of questions and a lively discussion at the first session of this year's Annual Meeting.

Another chapter was unfolded in the study of fuel characteristics and engine performance which has been sponsored by the Cooperative Fuel Research Steering Committee and conducted at the Bureau of Standards for more than six years. This joint undertaking of the American Petroleum Institute, the National Automobile Chamber of Commerce and the S.A.E., has during this time given a book of knowledge to the petroleum refiners, automobile manufacturers and users of motor-vehicles.

Previous experimental work on fuel volatility by Dr. O. C. Bridgeman, has shown that most of the gasoline properties needed for computations can be determined from the American Society for Testing Materials distillation curve, but the figures presented in Dr. Bridgeman's latest paper went still further. They indicate that the 10-per cent point on the A.S.T.M. curve tells virtually the whole story of vapor-pressure data for gasoline.

Earlier work resulted in the formulation of simple, practical methods for obtaining data on complete volatility, represented by dew-points, and on partial volatility covering the range from 10 to 90 per cent evaporated. These two phases of the volatility work left a gap at the lower end of the curves from 0 to 10 per cent evaporated; and the method adopted for investigating this range involved measurements of vapor pressure and determinations of the molecular weights of the vapors. The paper read by Dr. Bridgeman at this session dealt with the part of the program involving the vapor-pressure measurements and brought about a discussion on the relation of vapor pressure to the starting of a cool engine.

Economic Fuel Volatility

The paper entitled Economic Fuel Volatility and Engine Acceleration, by Donald B. Brooks, reported the effect of the A.S.T.M.. 50-per cent point on engine acceleration or the quantity of fuel required to give a stated acceleration. Tests included manifold temperatures from −10 to 100 deg. cent. (14 to 212 deg. fahr.), representing the extremes of winter warming-up and summer operating temperatures, from which Mr. Brooks concluded that the 50-per cent point has a negligible effect on engine acceleration except under summer operating conditions, when the acceleration improves or the required fuel decreases with decreasing A.S.T.M. 50-per cent point.

Dr. George Granger Brown, of the University of Michigan, who has conducted tests of a like nature, offered the possible explanation that, as the temperatures of the engine manifold are lowered, we should expect to compare the fuel at lower temperatures and likewise that during a certain period of acceleration the engine burns more fuel than actually is vaporized, an appreciable amount of fuel being swept along in drops or as a film on the walls of the manifold. Thus, Dr. Brown suggested, if a fuel shows a 30-per cent effective volatility, 20 per cent may be subtracted from this as being drops, mist or liquid carried in and burned, leaving the 10-per cent point as the point on the A.S.T.M. curve which might indicate 30 per cent effective volatility. If this assumption is correct, it could be carried a step further. Since practically all motor-cars are equipped with accelerating wells, and most carbureters are adjusted to give rich mixtures when idling, it may be expected that the manifold is actually being supplied with a mixture considerably richer than 12 to 1 immediately after the throttle is opened. Therefore, perhaps from 10 to 20 per cent of the fuel is carried in as a mist and the point on the A.S.T.M. curve which would indicate effective volatility would be somewhere between the 20 and the 50-per cent points.

The tests were conducted on an engine having no accelerating well, which Chairman MacCoull pointed out was an advantage from the viewpoint that an accelerating well is a much unwanted accessory on the carbureter and tests that might lead to disposing of it would be welcomed by the industry.

Mr. Brooks's second paper, Operating Factors and Engine Acceleration, showed the effect of other factors on

MEMBERS WHO REPORTED RESEARCH PROGRESS AT THE BUREAU OF STANDARDS
Dr. O. C. Bridgeman, Who Presented a Paper on Vapor-Pressure Data on Motor Gasolines at the Research Session; Neil MacCoull, of the Texas Co., Who Presided; Donald B. Brooks, Who Presented Papers on Economic Fuel Volatility and Engine Acceleration, and Operating Factors in Engine Acceleration; and H. H. Allen, Who Reported on the Headlight Research

acceleration. It covered tests made with pairs of cylinders firing; tests showing the effect of jacket temperature when the manifold temperature is low; data on the effect of spark advance on acceleration; data obtained when accelerating, as in low gear; and data showing the utility of the spark accelerometer in measuring engine friction.

SECOND PHASE OF HEADLIGHT RESEARCH

What is the relation between safe driving speed and headlight characteristics? What is the "spread demand" for average curves? How much does glare from an approaching car affect visibility distance? These are a few of the pertinent questions on headlighting requirements that are answered in the curves prepared and discussed by H. H. Allen, of the Bureau of Standards. For the last two years Mr. Allen has been at work on a program of headlight research sponsored by the Society and financed by the National Automobile Chamber of Commerce.

The first part of the program, covered in the paper presented at the 1928 Annual Meeting, consisted of observations made in the absence of approaching light to determine the effect on visibility of the speed of the car; the size, shape, color and other characteristics of the object observed; the intensity of the light source and the tilt and spread of the beam. These observations were supplemented by laboratory tests, and the second phase of the investigation was undertaken during 1928. In his present paper Mr. Allen considered the effect on visibility of the approaching light on straightaways, curves and in relation to the included vertical angle between the cars, and the effect of changing intensity upon visibility distance. A tentative relationship has been established between the intensity of light coming into the driver's eyes and that necessary on the road shoulder to ensure good visibility of the latter.

The method previously described for determining "spread demand" has been extended to cover all conditions likely to be met in normal driving, and the effect upon headlighting requirements of differences in braking performance and in driver alertness was discussed by the speaker.

Needs of the Overseas Market

Light Car and Communal Transport to Expand Exports—President Wall Reviews Engineering Achievements

DESIGN and production engineers had a real problem put to them at the Foreign Transportation Session on Tuesday night in the paper on The Economic Requirements of Automotive Road Vehicles Abroad, prepared by J. D. Mooney, president of the General Motors Export Co., and Clarence M. Foss, engineer of the General Motors Corp. staff. As Mr. Mooney was unexpectedly called to Europe the preceding week, Mr. Foss presented the paper in abstract form with the aid of numerous lantern slides of statements and charts. F. E. Moskovics presided in his usual energetic and humorous manner.

The major problem of the overseas market, as developed from studies of all the pertinent factors affecting the sale and use of motor vehicles in foreign countries, according to Mr. Mooney and Mr. Foss, is to provide a private passenger-car that can be sold overseas at a price to meet the slim pocketbook of a large class of possible buyers. Mr. Foss did not attempt to give the specifications of such a car or tell what it should be, beyond calling it a light car and asserting that it must have good appearance, give comfort and good performance, and must sell abroad in the $600 to $700 price level.

COLONEL WALL REVIEWS PROGRESS

President Wall, in his valedictory Presidential Address, pointed out that most of the progress of mankind in the last 2000 years has been along scientific lines and that, with the exception of medicine, which is itself a science, the invention of mechanical appliances and the applications of chemistry have probably been of the greatest benefit to the human race. We have gained little in morals, though they may be measured by different standards; nor in philosophy, which is no more advanced than in the time of Plato; nor are our laws much better although they are more numerous; and certainly in the last 500 years we have progressed little in the fine arts. But there is little question, he said, that the engineering development of the mechanical means of transportation has done more than

anything else to create what is called world civilization, and a large part of this has been accomplished during the lifetime of the present generation. The steamship, the locomotive, the motor-vehicle in all its forms, the airship and airplane, combined with telegraphy and telephony, all developed by the engineer, have made the world a small place.

Ranking high among the scientific and engineering achievements of the last year, said Colonel Wall, are television, completion and flight of the Graf Zeppelin, the improvement and building of airplanes and their power-plants, including the new Packard air-cooled Diesel engine and the refueling of an airplane in the air. A number of new devices brought out in the motor-vehicle field which he mentioned were the synchronized transmission, a new vibration damper, the Noback, the down-draft carbureter, the variable-degree booster brake, some new things in metallurgy, and two examples of what seem to be practical steam motorcoaches. The principal industrial development of the year, however, has been the great and economical production of motor-cars.

To the question that is often asked, What important mechanical improvements may be expected in the motor-car of the future? President Wall gave the answer: Those that will provide comfort and safety for the passenger and tend to eliminate physical effort on the part of the driver.

Reviewing very briefly the progress of the Society during the year of his administration, President Wall pointed to the admittance of nearly 700 new members; improvement made in the S.A.E. JOURNAL; issuance of TRANSACTIONS to members free of charge; the standardization headway made, especially by the Tire and Rim Division and the Aeronautic Division; the working out of plans for reorganization of the Society; progress in research on fuels, headlighting, riding-qualities and wheel alignment; success of the National meetings held; activity of the various Sections; and the working out of rules for the award of the Wright Brothers and the Manly Medals. Credit for these various accomplishments was given to the respective committees.

How Price Situation Has Changed

Mr. Foss, in his address, pointed out that, whereas in 1924 the United States was building cars to sell f.o.b. at $260 and $490 respectively for roadsters of two makes and at $290 and $495 respectively for the touring car or phaeton type, these same makes are priced this year at $450 and $525 for the roadsters and $460 and $525 for the phaetons. This increase has put them in the next higher price level, and the retail price just about doubles in overseas markets. A model that sells for $675 in Detroit lists at $1,142 in London; $1,100 in Berlin; $1,287 in Port Elizabeth, South Africa; $1,355 in Wellington, New Zealand; and $1,527 in Melbourne, Australia. To the London price must be added a tax of $106, and to the Berlin price a tax of $96.25. At the same time, the per capita wealth, which is roughly indicative of purchasing power, in 13 countries of Europe, South America and New Zealand is estimated to be only two-thirds as much as in the United States.

Charts were presented to show how the foreign market could be expanded from 8,000,000 to 15,000,000 potential buyers by providing cars to sell in the next lower price level in these 13 countries, that is, in the $600 to $700 class, for which there is a volume market as yet untouched. It is estimated that potentialities of 2¼ to 2½ times the present market can be created if a product can be supplied overseas on the same economic basis as is now being supplied in the United States. Besides being low in first cost, the light car must be economical in operation and upkeep, because of the relatively high cost of fuel and replacements abroad.

To reach a still larger class of potential automotive transportation users overseas, Mr. Foss said there is need of communal vehicles, that is, motorcoaches and motor-trucks. The coaches can provide transportation en masse for passengers who cannot afford individual or private cars, and the trucks can haul goods economically.

Low Price Hinges on Volume

Upon the conclusion of the address several discussers sought to draw from Mr. Foss more specifically what the suggested light car should be, whether he thought it possible for the engineers to produce it at the necessary low cost, whether a sufficiently large production could be attained to make the low price possible, and in what respects American cars need to be changed to meet the operating conditions in foreign countries.

To a question by G. L. McCain, of the Chrysler Corp., Mr. Foss replied that the improvements which engineers are now making in cars should fit them for the overseas market, as it is not a question of the size or kind of car but is one of getting into the proper price class. The three procedures indicated by the analyses of conditions are, first, to make the present car a little more available to foreign buyers by getting the price down; second, to make a smaller type of car that would sell in a lower price level; and, third, to develop motorcoaches and motor-trucks for mass transportation. The basic requirement is to provide transportation overseas on the same economic basis as in the United States, taking into consideration the relative purchasing power of the peoples.

Foreign Fuels Too Good

Lester A. Garrard, of the Standard Oil Co. of New York, who stated that he had been out in the field in the countries of the Orient since 1923, pointed out some of the difficulties encountered with American cars. Most of the cars are operating under sea-level conditions, high temperatures and wide differences in fuels and barometric pressure compared with conditions in this Country. High-compression fuels are not available in many places and, as gasoline costs 40 cents per gal. in various localities, car users will not buy premium fuels. Consequently, to obtain satisfactory performance, it becomes necessary to remove the shields from around the carbureter, take off manifold connections that supply heat to the fuel mixture, and sometimes even to move the vacuum tank from beneath the dash so that the gasoline will not boil in the carbureter. Cars provided with thermostatic control set for conditions in this Country cause too much heating of the mixture in Java and the Straits Settlements and slow the car down. Such countries use locally produced fuel, which invariably is high-test gasoline, and if heating of the mixture can be eliminated an average of 4 miles per gal. more mileage can be obtained from the car and about 2 sec. quicker acceleration from 5 to 35 m.p.h. can be secured.

Another difficulty encountered is wood rot in the tropics. After 16 to 18 months the usual automobile body must have the wood parts partly or wholly rebuilt because of dry rot. Various other freakish conditions exist, and if these were taken into consideration and provided against, it would help greatly those who are selling American cars in those countries.

Cooperation Solved Fuel Problem

Much the same trouble on account of fuel was found in one of the countries mentioned by Mr. Garrard, said William M. Hoag, of the Ford Motor Co., who recently returned from it. Instead of trying to re-engineer the cars to overcome the troubles caused by too much heat, the representatives of the company got together with the fuel people and it was decided to supply the kind of fuel for which the American cars were designed. Most of the fuel that was being sold at the time was high test, but small quantities of the right type for the cars were in the market. By getting the oil companies to cooperate, this position was reversed, and after that time three-quarters of the fuel sold was low test. This movement was supplemented by a campaign to educate the car dealers and car owners to the importance of using the low-test fuel in the American cars. This relieved the dealers in American cars of the need of carrying a type of fuel especially for American cars and also

of getting into trouble in the matter of adjustment of the carbureter and the amount of heat on the manifold. Mr. Hoag said he thinks that wherever American cars begin to predominate in the market there will be no difficulty with fuels for any length of time if such a course is followed.

Big Market for Light Car

Norman G. Shidle, of the Chilton Class Journal Co., pointed out that no type of light car has been successful in the United States because we have the low-priced full-size car, the price of which could be made low because of quantity production for the home market. He asked Mr. Foss if, under these conditions, he believes it is feasible for an American manufacturer to build such a car solely for the foreign market and get a sufficient production to make the low price possible. In response, Mr. Foss said that he put the matter another way: if a manufacturer in this Country wants to get volume production for the foreign market he must make a light car. In the overseas market the price of all cars is high and the prospective buyer has a thin pocketbook, whereas in this Country we have the highest purchasing-power relation of any country in the world and the lowest over-all cost of automobiles. He regretted that he could not tell how the low-priced car should be built or how many of them, but it is being done in Europe; light cars made in four countries over there are being sold and used throughout the world alongside of the present type of American cars, and the greatest production in the four European manufacturing countries is in the light-car class. Today in this Country we have no cars in the very low-price classes. Have we all become so rich overnight, inquired Mr. Foss, that we cannot put a car down in the lower price level here?

How all the world is engaged in the production, use, servicing and maintenance of the motor-car was shown most interestingly and instructively in a series of motion-picture reels entitled, The World Builds a Motor-Car, which were run off at the conclusion of Mr. Foss's address. Starting with early trade routes in Asia Minor which extended civilization and culture around the shores of the Caspian and Mediterranean Seas, this traced the development of transportation from the camel and crude sailing boats to the present railroad train, steamship and airplane. It showed how the automobile industry draws on the natural resources and manufacturing industries of many countries for raw and finished materials entering into the motor-vehicle; and showed assembling work being done on American cars in various countries of Europe, South America, Africa, the Antipodes and the Orient. How the workers of many countries earn their livelihood by assembling and servicing American cars was indicated by a series of views showing them drawing their pay in various currencies. The ubiquitousness of automobile traffic and parking were also shown.

It seems highly probable that, if exhibited in the various countries of the world, these pictures should have an important influence in creating good-will for the American motor-car in all its forms. The showing at the meeting was received with rapt attention and with hearty applause at the end.

The Foreign Automotive Transportation Session

Clarence M. Foss (Left), Engineer, General Motors Export Co. Staff, Who Presented a Paper Which He Prepared with J. D. Mooney; F. E. Moskovics, Who Presided at the Session; and Kirke K. Hoagg (Right), Who Took Part in the Discussion

Transportation Committee Dinner-Meeting

At the dinner meeting of the Transportation Committee of the Society, held Jan. 14 at the Book-Cadillac Hotel, F. C. Horner, chairman of the Committee, presided and welcomed the representatives present. He expressed his realization that they are busy men, but urged their attendance at Committee meetings and their full cooperation.

Those present included President-Elect W. R. Strickland, Chairman F. C. Horner, General Manager C. F. Clarkson, and Messrs. H. Dakin, H. L. Debbink, F. K. Glynn, H. W. Kizer, E. F. Loomis, G. O. Pooley, C. S. Putnam, A. J. Scaife, F. J. Scarr, Pierre Schon, R. S. Burnett and F. H. Hazard.

Discussion relating to the most suitable time to hold the Transportation Meeting of the Society brought out the fact that a meeting in April is desirable. Of 23 replies to a questionnaire circulated by the Meetings Department, 11 favored holding a meeting in the spring; 10 were neutral and 2 preferred a fall meeting.

Mr. Loomis described plans now in progress for a three-day motor-truck pageant to be held next April at Camp

Holabird, Md., at which motor-trucks of all models will be exhibited and demonstrated, as well as other motor-vehicles, maintenance equipment, plant and operation, under the auspices of the Army. Government officials are to attend and manufacturers are to be invited. It was stated also that the participation of the Society would be welcomed by the officials, and Mr. Loomis suggested that the Society should take part in the affair.

Chairman Horner favored holding the Transportation Meeting in April in conjunction with the Camp Holabird pageant. On motion duly seconded it was voted that, unless substantial objection develops, the Transportation Meeting be held in April, and that it be held conjointly with the Camp Holabird pageant if the plans can be worked out satisfactorily.

The Committee discussed the class and number of papers that might be developed for the Transportation meeting in April. It was felt that if the plan for a joint meeting with the Motor-Transport Division at Camp Holabird matures, a considerable S.A.E. program should be developed by the Transportation Committee.

Semi-Annual-Meeting Session

On motion duly seconded it was voted to recommend that a Transportation session be arranged for the Semi-Annual Meeting of the Society next June. A recommendation was made that three papers be presented provided that they be presented in abstract form so as to permit adequate general discussion, and that the papers deal with (*a*) long-distance motorcoach operating, (*b*) heavy-freight transportation, and (*c*) light-delivery transportation such as that for delivery of retail drygoods. It was agreed that these recommendations be submitted to the Meetings Committee for action.

Committee Organization

Chairman Horner presented the plan of having three regional Vice-Chairmen of the Transportation Committee to serve as contacts with transportation engineers in their territories, to cultivate transportation activities in the local Sections, to assist in securing data desired, to interest transportation engineers in becoming members of the Society, and otherwise to do what they can to further transportation activities in their own territories.

The direct work of the Transportation Committee will be allotted among four Subcommittees, as follows: Uniform Cost-Record Forms, No. 1; Operation, No. 2; Maintenance, No. 3; and Meetings, No. 4.

Chairman Horner announced the appointment of the three following regional Vice-Chairmen of the Committee: C. C. Clark, for the East; H. L. Debbink, for the Midwest; and Eugene Power for the West. He said that these appointments had been duly approved by President-Elect Strickland.

Remarks by President-Elect Strickland

Mr. Strickland then described briefly the development of the Society's interest in behalf of the transportation members and engineers, and said that the Council desires to do all it can to further their interests in the Society. He pointed out that one difficulty may be the financing of some of the Committee's projects, but that he and the Council feel confident that ways and means will be developed for meeting these necessities.

Chairman Horner responded appropriately, indicating that the transportation-engineering members feel that they have some very real problems that should be taken up and that it is hoped the transportation activities will soon become one of the major branches of the Society's activities. He also indicated that, for some of the more important projects, it may be feasible to work out a plan whereby outside financial assistance can be secured from other organizations mutually interested in the Transportation Committee's problems.

Subcommittee Appointments and Subjects

Chairman Horner then announced that he would designate the Chairmen of the Subcommittees as soon as possible, together with such other appointments on Subcommittees as he feels should be made; but with the understanding that each Subcommittee Chairman may appoint additional members from the Transportation Committee, the Society membership at large or from non-members of the Society. He requested that all members of the Transportation Committee suggest five problems that they feel the Subcommittee on Operation and the Subcommittee on Maintenance each should consider taking up; and that, likewise, suggestions are desired as to the topics for papers and desirable authors for the National Transportation Meeting and the Transportation Session at the Summer Meeting. General discussion relating to the program for the Transportation Committee and its Subcommittees followed, after which the meeting was adjourned.

Transmission Problems

Axle Ratios, Underdriving, Overdriving, Gear-Noise Analysis and Reverse Brake Discussed

SUCCESS of the four-speed transmission, which has made fast rear-axle ratios practicable and usable within the last several years, has caused its benefits to become better understood, according to S. O. White, chief engineer of the Warner Gear Co., who was chairman of the Transmission Session held Wednesday morning, Jan. 16. Axle Ratios and Transmission Steps was the subject of the principal paper, of which Carl D. Peterson, of Durant Motors, Inc., was the author. Discussion on the subject of Underdriving versus Overdriving, prepared by C. A. Neracher, consulting engineer, was read by G. A. Round, of the Vacuum Oil Co. Prepared discussion was also submitted by E. S. Marks, of the H. H. Franklin Mfg. Co.; H. M. Crane, of the General Motors Corp.; G. C. Mather, of the Warner Gear Co.; F. C. Thompson, of the Morse Chain Co.; and others. Floyd A. Firestone, of the University of Michigan, demonstrated apparatus developed for the purpose of analyzing gear noises. A paper describing an automatic reverse-brake was contributed by J. G. Monjar, of the Detroit Gear & Machine Co.

The session was fairly well attended, there being 125 members and guests present. Much interest was manifested in the subjects presented, as was attested by the numerous questions asked and answered.

Axle Ratios and Transmission Steps

Durability, smoothness, flexibility, and fuel and oil economy should be characteristics of all modern automobiles. Almost all of today's cars have a high degree of durability and reliability; but Mr. Peterson said that improvement can be made in securing increased smoothness, flexibility and economy by selecting axle ratios and transmission steps that make possible the present high road-speeds at engine speeds considerably lower than those generally resorted to, without the use of larger engines for a car of given weight. It is the author's contention that one of the major causes of the roughness and noise that rack the car-user's nerves is the result of high axle-ratios and high engine-speeds at average car-speeds.

With few exceptions, it seems to Mr. Peterson that axle ratios have been made high and wheel diameters decreased to secure high-gear flexibility with three-speed transmissions, and this results in high engine-speed even

at moderate car-speeds. Such a condition provides flexibility at a sacrifice of smoothness and economy.

Another alternative resorted to is a low axle-ratio and a larger engine than would be required with a high axle-ratio and three-speed transmission for the same flexibility. The larger and heavier engine necessitates a larger clutch, transmission, propeller-shaft, axles and other parts. In short, nearly every part of a car would be increased in weight, which would result in higher cost to the manufacturer and purchaser, and such a car would be likely to cost more to operate.

An experimental car was used which Mr. Peterson said had the following characteristics: Weight, 3300 lb. and, with driver and observer, 3700 lb.; frontal area, 27.5 sq. ft.; and rolling diameter of the wheels, 29 in. It was driven by a six-cylinder engine. At the maximum horsepower-output, which developed at approximately 3100 r.p.m., it was calculated that the car should have a speed of approximately 72 m.p.h. and that the rear-axle ratio should be 3.72 to 1. The low-gear ratio was determined after assuming that, at the maximum horsepower-output of the engine, the car should be able to climb a grade of 20 to 25 per cent in first speed. A low-gear ratio of 14.6 to 1 was decided upon, which gave a grade ability of slightly more than 23 per cent.

The internal-gear reduction provided in the transmission supplemented the high or fourth-speed reduction and, according to Mr. Peterson, gave results identical with those of a two-speed axle having gear ratios the same as the third and fourth-speed ratios. This third speed provided a quiet high-speed driving-range and gave a high accelerating and hill-climbing ability at relatively high car-speeds.

The method of selecting the gear ratios was described, the final total and transmission ratios being as follows:

Speeds	Total	Transmission
First	14.60 to 1	3.920 to 1
Second	8.89 to 1	2.391 to 1
Third	5.18 to 1	1.394 to 1
Fourth	3.72 to 1	1.000 to 1

The reverse ratio should be equal to or greater than the low-gear ratio, Mr. Peterson said, and for this car it was made equal to the first-speed ratio. He then exhibited charts illustrative of the performance of the car and commented upon its various features.

Underdriving versus Overdriving

In discussing underdriving versus overdriving, C. A. Neracher said that the two terms apply to a method of power transmission through a double internal gearset in combination with a suitable clutch. He defined underdriving as being an arrangement of the gearing such that propeller-shaft speeds are less than engine speeds, and overdriving as being an arrangement of the same gearing such that propeller-shaft speeds are in excess of engine speeds. The functioning of either of the systems is exactly equivalent to that of a two-speed axle, he said, making this reference to clarify the status of so-called four-speed "overdriven" or "underdriven" gearsets.

In the four-speed transmission of the conventional type, no special change is made in axle ratios; whereas, in the internal type, a much lower axle-reduction is used. The over-all reduction between the crankshaft and rear axle is the same when underdriving as when overdriving, but in underdriving the reduction in the fourth speed is made in a single step at the axle, whereas, in overdriving, there is a step-up in speed at the internal gearset and a resultant greater step-down in speed at the axle ring-gear and pinion. Consequently, internal gears arranged for underdriving make for better, lighter, and cheaper rear-axles. In Mr. Neracher's opinion, the only justification for overdriving seems to be under circumstances that demand the use of the third speed, which in that case is direct drive, a greater percentage of the time than use of fourth or top gear. He stated that he has had no experience when such circumstances prevail.

E. S. Marks said in part that he does not believe the fact of a *quiet* speed next to high gear has been given the attention it deserves. The internal-gear idea incorporated into a three-speed transmission with the proper selection of ratios with relation to car weight gives a start from the curb in second gear without gear noise, and also an exceptionally high degree of noiseless flexibility in traffic. The lower engine-speed at high car-speed is desirable. The question is whether the best all-round satisfaction will be obtained by asking the owner to shift more than he has been accustomed to shift, or whether the owner will demand the smoother and more comfortable operation at high car-speed without shifting, such as can be ob-

Discussers at the Transmission Session

(Left to Right, Upper Row)—E. S. Marks, of the H. H. Franklin Mfg. Co.; S. O. White, of the Warner Gear Co., Who Presided; Floyd A. Firestone, of the University of Michigan; (Left to Right, Lower Row)—J. G. Monjar, Who Prepared a Joint Discussion with H. E. Blood, of the Detroit Gear & Machine Co.; J. F. Wallace, of the Detroit Gear & Machine Co.; and H. M. Crane, of the General Motors Corp.

tained by getting more power out of an engine of a given size, an increase in the capacity of the engine, or a decrease in the weight of the car.

Four-Speed Gearbox a Compromise

H. M. Crane characterized the four-speed gearbox as a sort of compromise; engineers make this compromise as as best they can and take into consideration conditions of operation that will affect the majority of the owners. At present, with the very flexible engines now available, he said that the slowing down of the engine at high car-speed is desirable to reduce wear on the engine and to reduce fuel consumption. The questions of the car builder are: How many people drive a car at high speeds? How much do they care about gasoline consumption? How much do they care about lack of gearshifting, and about violent acceleration in top gear? In his opinion, the industry has been at fault in attempting to emphasize the importance of certain things, such as the ability to accelerate in high gear and to climb hills in high gear, because such results can be obtained only by definite losses in other directions. The situation with regard to the commercial motor-truck is entirely different in that the four-speed gearbox is rapidly coming into use because of needing an emergency starting-gear that is much lower than is worth putting into the usual passenger-car. One reason for this is that the truck user has found by experience how conservative engineers are in rating the load capacity.

In conclusion, Mr. Crane doubted that half of the owners of passenger-cars are driving at speeds above 40 m.p.h. For that reason he doubted also the desirability of four-speed transmissions and said that certainly the public would need to be educated to use them intelligently if they are provided.

Surprise was expressed by G. C. Mather at having found such differences of opinion among the engineers of the various motor-car companies regarding the four-speed transmission. Some of them believe that if the ratio between engine displacement and weight is favorable enough there is no need for a four-speed transmission, and others feel that a four-speed transmission should be used in conjunction with a relatively small engine and that frequent gearshifting should be considered. In Mr. Mather's estimation, both of these lines of thought are incorrect. First, any automobile that is geared to provide, with a three-speed transmission, the performance which the American public demands, is geared entirely too slow for more than 90 per cent of driving even under very hilly conditions. Any car can be geared faster if a four-speed transmission is used, and the higher gear-ratio will be used for most of the driving. He stated also that present standards of weight and engine displacement should be continued and, as a further refinement, a four-speed transmission should be installed.

Several Transmission Types Needed

Transmissions, axles, and axle ratios should be considered for all makes, sizes and types of car, rather than for any special case, in the opinion of F. C. Thompson. When it is considered that the weight of the passenger-cars being built today varies from 16 to 12 lb. per cu. in., of piston displacement and that to obtain the required acceleration and hill-climbing ability the axle ratios vary from 3.2:1 to 5.6:1, it is reasonable to assume that consideration should be given to more than one type of transmission. His company has been building sample transmissions of the internal-gear type for automobile manufacturers and its recommendations as to the type of transmission to use are generally as follows:

In cases where proper performance is obtained on direct drive with an axle ratio of 3.2:1 to 3.8:1, the recommendation is for the three-speed transmission direct on third speed. On a car in which the proper car performance is obtained on direct drive with a ratio of 3.8:1 to 4.0:1, the company would recommend a four-speed transmission direct on fourth speed. With axle ratios of 4.00 to 4.75:, the recommendation would be to build samples of both four-speed direct on fourth speed and four-speed direct on third speed, and then to determine the correct type of transmission from actual test. With axle ratios of 4.75 to 5.60:1, the four-speed transmission direct on third speed is recommended.

In most cases in which the company has inquired whether the transmission should be direct on third speed or on fourth speed, the manufacturer has decided on four-speed transmission direct on third speed.

Detection of Gear Noises

Apparatus developed for the purpose of detecting, locating and measuring gear-noise intensity was demonstrated and explained by Floyd A. Firestone, of the University of Michigan. By means of the apparatus the loudness of a sound is indicated on a dial, and the pitch of that sound is indicated on another dial. If the pitch is known, the origin of the sound can be determined by computation. Since the pitch of the sound originating in a set of gears is determined by the number of teeth that come into mesh per second, and since the apparatus can be tuned to any pitch, if several sets of gears are running at the same time the apparatus can be tuned to pick out the pitch of the sound originating in any given set and the sound intensity can be measured, regardless of the sound made by the other sets of gears. Thus a gear which is causing noise can be located.

The apparatus includes a microphone which is itself tuned to one specific pitch, a vacuum-tube amplifier, the dials already mentioned, and devices for picking up sounds originating from vibration. It is portable and is designed for use in a car that is operating on the road. To demonstrate the way in which the apparatus is utilized, Mr. Firestone set a microphone on the sounding board of a piano and illustrated how the dials become responsive to certain notes struck on the piano keys.

Automatic Reverse-Brake

According to J. G. Monjar, the ideal automatic reverse-brake is one which will function instantly upon the cessation of forward motion of a car, prior to any reverse motion or at the instant of coming to rest, and thus prevent rather than check reverse motion. It must be noiseless in operation at all speeds, must have positive reverse-locking action in all forward speeds and in neutral position, and be automatic in its locking operation. Its releasing operation must not require any special instruction of drivers, and must be free for both forward and reverse release. The device must be simple in construction and designed and built to outlast the car to which it is applied, and its application must impose no additional stresses upon the mechanism of the car.

The automatic reverse-brake in which Mr. Monjar's company is interested is known as the Noback. It was exhibited and demonstrated, and details of the tests made and of the advantages claimed for it were given. In the absence of Mr. Monjar, his paper was read by R. L. Wallace, who invented the device. Numerous questions regarding details of its operation were answered in the course of the discussion by Mr. Wallace and by H. E. Blood, both of whom are connected with Mr. Monjar's company.

Sections and Membership Committees Meet Together

A WELL-ATTENDED and very lively joint meeting of the Sections Committee and the Membership Committee was held at the Book-Cadillac, Detroit, during the forenoon of Jan. 15, the first day of the Annual Meeting. Chairman V. G. Apple, of the Sections Committee, presided.

After discussing various problems connected with student membership and activities, a resolution was passed

(*Continued on p.* 221)

Chronicle and Comment

Proposed Reorganization Plan

DISCUSSION of the proposed reorganization plan was had at the Annual Meeting in a manner that raised apparently the points involved in the new procedure for which there has been forceful argument. The discussion is transcribed on page 214 of this issue. The members are urged to peruse it prior to further discussion at the time of the Summer Meeting.

W. R. Strickland Inducted as President

AT the close of the last session of the 1929 Annual Meeting on the evening of Jan. 18, W. R. Strickland became President of the Society for the current administrative year. At the Body Dinner-Session, sponsored by the Body Division of the Detroit Section, at the Annual Meeting, Mr. Strickland commented briefly on the policies for the year. The other members of the 1929 Council, including those elected this and last year, are listed on page 214 of this issue. There never has been a more important or promising time in the history of the Society than the present year.

1929 Nominating Committee

THE 1929 Nominating Committee held sessions during the Annual Meeting in Detroit last month, A. J. Scaife and O. C. Berry having been named as Chairman and Secretary respectively of the Committee. Messrs. Scaife and Berry, in addition to F. E. Moskovics, were elected members-at-large of the Committee at the Business Session of the Annual Meeting.

Representatives elected by the Sections who attended the Nominating Committee sessions were: Taliaferro Milton (Chicago); W. E. England (Cleveland); V. G. Apple (Dayton); W. C. Keys (Detroit); H. A. Huebotter (Indiana); George A. Round (Metropolitan); Albert Lodge (New England) and D. Risley, Jr. (Pennsylvania).

The Annual Meeting

A TREMENDOUS amount of Society activity is concentrated in the four days of an Annual Meeting. The 1929 Annual Meeting was the largest in number of attendants and in papers and discussions presented, and in incidental activity of the machinery of the Society, of any meeting held heretofore.

The meeting reflected the growth, not only in membership, but in activity of the various fields of automotive engineering embraced by the Society. It was equally reflective of the great amount of study and energy now being devoted with most painstaking care to efforts to further improve automotive vehicles and their components. The search for ways of increasing the performance, appearance, comfort, reliability, and durability of motor-cars and at the same time to keep the prices low has grown intense. All the engineers are alert to get all the latest available information bearing on prospective changes in design. While standardization is a major branch of the work of the Society, nothing seems more evident than that motor-vehicle design is far from having reached a stage of final settlement. On the contrary, fundamentals are under close scrutiny, and radical changes are not unlikely within the next few years.

Designation of Transportation Activities

IT will be noticed that the heading "Transportation Engineering" has been substituted for the former heading "Operation and Maintenance" in the department devoted to the interests of motor-vehicle-fleet operators. This is due to the fact that the name of the Society's committee for furthering operating activities was changed when the 1929 Committee was appointed. In 1928 the Committee was officially known as the Operation and Maintenance Committee; for 1929 it is known as the Transportation Committee.

New Production Standard

ATTENTION is especially called to the new Standard for Plain Cylindrical Ring-Gages, for diameters up to and including $4\frac{1}{2}$ in., that was approved at the Annual Meeting and will be ready for publication soon, separately from the S.A.E. HANDBOOK. All members of the Society who want a copy of this report should notify the Standards Department at the Society's New York City offices before Feb. 18, as the number to be printed will be determined by the number of requests received.

Conference with Railroad Men

FRIDAY, March 1, 1929, has been set aside by the Motor Transport Division of the American Railway Association for a joint conference of interested members of the American Electric Railway Association, the National Automobile Chamber of Commerce, the American Automobile Association, and the Society of Automotive Engineers for discussion of matters of mutual interset.

This conference is to be held at the New Hotel Jefferson in St. Louis on the day following the meeting of the Motor Transport Division during the last three days in February.

On behalf of Chairman A. P. Russell, of the Division, Secretary G. M. Campbell has extended to the officers and members of the Society a cordial invitation to participate in the joint conference, which is to start at 10 a. m., March 1.

As the conference will constitute another step toward the cooperation desired for further coordination of rail and highway transportation, it is hoped that the Society will be adequately represented.

Similar conferences were held in June, 1928, at Atlantic City, and in October, 1928, at Detroit, the forthcoming conference being the third. Suggestions as to pertinent subjects that should be considered at this conference are desired. They may be sent direct to G. M. Campbell, Secretary of the Motor-Transport Division of the American Railway Association, 30 Vesey Street, New York City.

An "Impossibility" Realized

By Walter T. Fishleigh[1]

UNTIL recently engineering was regarded as a dry subject, lacking in vigor, in enthusiasm, in appeal. Like its close relation, mathematics, it presumed the long face, the tiresome discussion, the intellectual scowl. And, by the same token, engineering meetings were synonymous with long-faced, tiresome discussions of dry subjects. That was the general reputation, and the facts bore out the reputation. It was impossible to think of an engineering meeting in terms of inspiration and enthusiasm, entertainment and good-fellowship, music and good food. To combine real enjoyment with an engineering meeting was an "impossibility"; the two did not mix. That was a few years ago.

Today, in the S.A.E., that picture has been entirely changed. Not only has the Society banded its members into the most active and powerful association of technical engineers the world has ever seen, but it has brought to the world, and to engineers in particular, new and unheard-of visions of inspiring and enjoyable technical meetings. Instead of the old-time dry, all-technical sessions, the members have recognized the great auxiliary value of entertainment, music, inspirational speeches, good food, good-fellowship and real enthusiasm. Not that the technical nature or value or scope of the main papers and discussions has been changed or curtailed. On the contrary these qualities have been strengthened. But, as preliminaries and in addition to the main papers, features have been added which bring inspiration and enjoyment, and the "can't-miss-the-next-one" spirit.

By the Detroit Section, especially, for two years, experiments have been tried looking toward bigger and better technical results. Interest and attendance have increased five-fold, the type of speakers and technical papers has steadily improved, entertainment and good-fellowship have been made an integral part of each meeting. And, as a matter of record, holding their dinners and meetings in the largest hotel ballroom in the City of Detroit, time after time the officers have been forced to hang out the sign, Standing Room Only.

The fundamentals that have produced these "miracles miraculous," and which are so simple that they can be "put over" in every section of the Country are:

(1) *Best of Food* and at low prices. Properly capitalizing upon the advertising value of large S.A.E. meetings, regularly held, enables every Section to offer the best of dinners at the best hotel or club at a price which is a bargain.

(2) *Entertainment* during dinner. With a first-class small orchestra or band, together with two or three first-class vaudeville acts; songs, dancing acts, xylophone, or the like, with not too many acts, but quality the best and snappily executed, there need be no worry about the good nature and spirit of the crowd.

(3) *Surprise Speakers.* Two or three unannounced guest-speakers at each meeting for short, snappy talks, as noted engineers, National S.A.E. officers, executives of various companies, Army and Navy men, local city officials, or prominent politicians. Such three-minute talks, humorous when possible, build up tremendously the interest and "background" of the meeting. Introduction of celebrities, even though they do not speak, always adds interest and no chance to do this should be missed.

(4) *Publicity.* A reasonable amount of publicity is not only desirable but actually necessary for full success. Keep the members posted and they will be interested. Brief anticipatory outlines of plans for next meetings by the Chairmen of the Meetings Committee, Entertainment Committee and Reception Committee arouse enthusiasm. A good publicity man to handle newspaper articles has tremendous value.

(5) *Main Papers and Speakers,* the best there are! In a successful meeting, nothing short of a "corking" good main speaker can suffice. The better he is, the greater will be the interest and the crowd, and the better the dinner, entertainment and preliminary speakers will "go over." And the greater the interest and the crowd are, the better will be the speakers who can be obtained.

(6) *Attractive Announcements,* full of snap and to the point, with photographs and personal hits and real selling of the "show." Most S.A.E. Section announcements would discourage the prospect, even if the previous meeting had not. In every Section there is someone, talented and willing to work, who, if given the backing and recognition, can make the announcements a success. Detroit Section's *Supercharger,* with its "classy" cover designs in three colors and its inside snap, humor, technical selling-appeal and photographs, has been no small factor in building up attendance and enthusiasm.

(7) *Promptness and Snap.* Dinner and entertainment and meetings should start and end promptly "on the dot." There is no need for any dinner or meeting to drag or be dull if it is properly planned and the members are directed in "putting it across." They like promptness and snap.

(8) *Cordial Good-Fellowship.* A Membership Reception Committee who will be on the job, extending a real handshake and welcome to everyone at every meeting, introducing the strangers, acting as big brother to the young men and as host to all in the general social half-hour which should follow, and be advertised to follow, every meeting. Good-fellowship and enthusiasm are contagious, especially among engineers, who seldom get a chance to make use of them.

(9) *Officers and Committeemen,* chosen, not as an honorary gesture, but because they will take genuine interest in and devote time to making meetings all that they should be. It is hard work, but the kind which, when well performed, spells genuine satisfaction.

In the Society, engineers and engineering meetings have come to be synonymous with vigor, enthusiasm, inspiration. In the S.A.E. is an "impossibility" realized.

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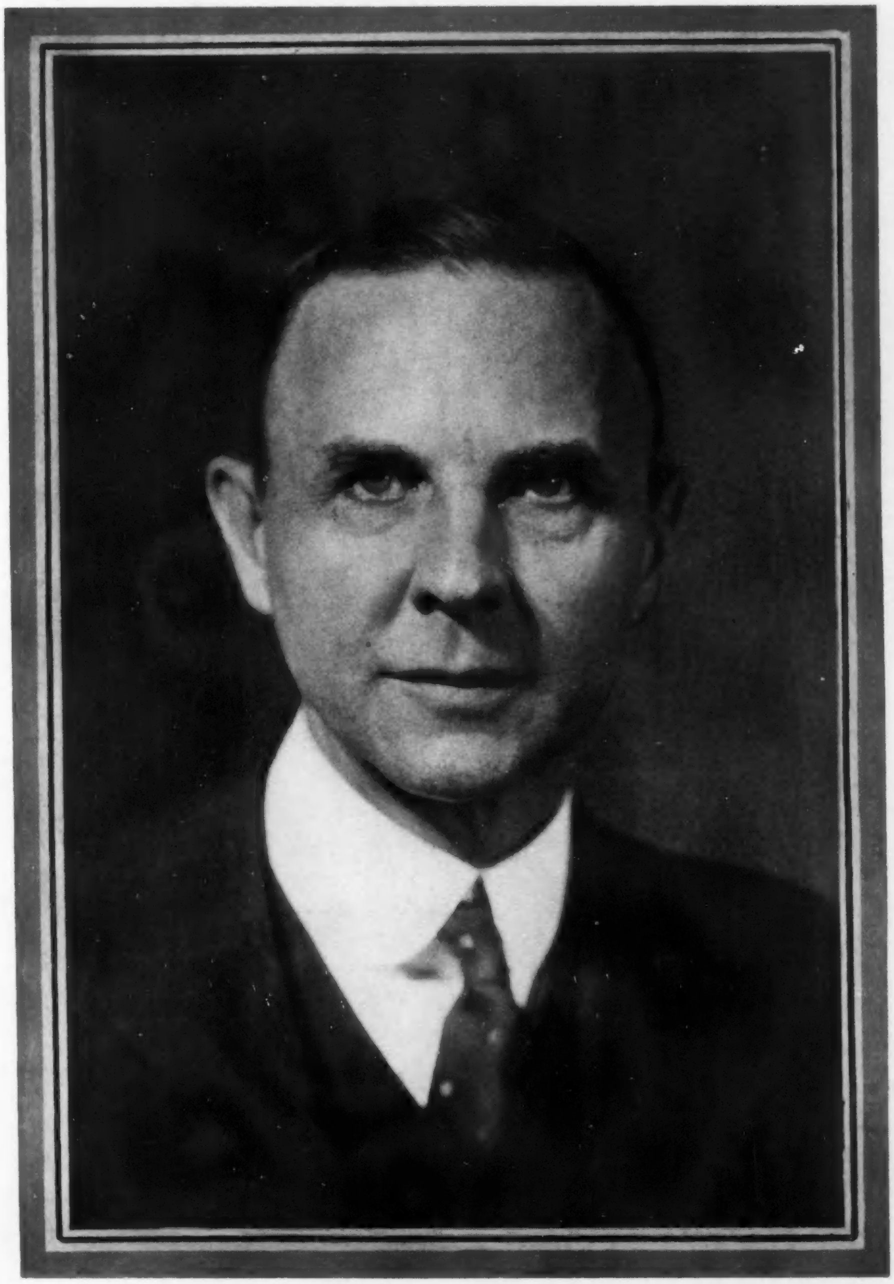

WALTER T. FISHLEIGH

The exponent of a new type of engineering meeting, who, by his enthusiasm, energy and inspiration, put the Detroit Section, of which he was Chairman last year, into the leadership in size, attendance at meetings and progressiveness in pioneering new movements. He is eager to see all meetings of the Society and its other Sections raised to the same pitch of enthusiasm, good fellowship and enjoyment as have been those of the Detroit Section.

Accounting for Depreciation as a Production Cost

By L. A. Baron[1]

Production Meeting Paper

If the costs of almost any group of manufacturers who market the same product are analyzed, two kinds of differences will be detected, according to the author. The real differences in costs arise from superior management, higher productivity, and better disposition and utilization of capital. The accidental differences result from the failure of manufacturers to include in cost records all of the proper legitimate items of expense.

Confining his treatment of the subject to an analysis of the depreciation of plant and equipment, the author states that depreciation is a decline in the value which is certain to occur as a result of wear and tear and gradual obsolescence. It is caused by the possession and use of an asset, and is therefore a part of the cost of production. The accountant attempts to recover depreciation loss in the value of the capital assets by charging it into the cost of production. This cost must be collected as the product is sold, and the primary questions are the determination of the proper charge as to the amount of depreciation and to how to charge it.

Engineers must predict the useful economic life of a plant or equipment from a painstaking, intelligent estimate backed by the experience of the estimator and the trade in general, since there is no standard rate of depreciation for all businesses or for like equipment used in the same line of business. Since it is much safer to have the property outlive the estimated life than to have its usefulness terminate before its cost has been written off, the author advises that estimators be conservative when calculating the useful life of property.

Having established a reasonable useful economic life for each class of plant or equipment, it is then necessary to determine a method of calculating the costs and of applying the results to production. The paper outlines the various methods in use, recommends that permanent records be kept of all assets, and states that a suitable classification of property is a prerequisite for the correct recording of depreciation. An accurate record of depreciation requires that the specific items and units of property be enumerated and classified by kind, group or department, and that their original cost be ascertained as well as their accumulated depreciation and remaining term of useful life.

Other subjects covered by the author include details of proper charges, depreciation on original replacement cost, reserve fund for replacements, the budget system, and a statement of six rules for making charges on account of depreciation.

SEVERAL years ago three men purchased a concession device in an amusement park at Indianapolis for $15,000, and assumed the lease of the original owner. One of the conditions of this lease was that, when the lease expired, the device should revert to the lessor. The three purchasers formed a corporation to operate the business. A few months afterward, two of the partners desired to go to Florida but did not want to leave the business in the care of the third member without providing some means of checking him up. Their attorney recommended that they hire an accountant to audit all receipts and disbursements. A deal finally was made, and the accountant agreed to keep a set of books which would show the complete history of the business. He agreed also to send to the absent owners monthly operating statements showing all charges paid and accrued. After the first report was mailed, the accountant received a special-delivery letter in which was the question: "What we should like to know is, who got the $500 paid for depreciation?"

Accounting for the depreciation of plant and equipment and applying that charge to the product is a large problem. The Accountant's Index has more than 430 pages of reference on this subject. No one man could cover the subject in all its details. I can only hope to touch some of the important points. By so doing, I hope to bring about a better understanding between the production man and the accountant on the question of applying all rightful charges to production.

Real and Accidental Cost Differences

It is said that if the costs of almost any group of manufacturers who market the same product is analyzed, two kinds of difference will be detected; one is real, the other is accidental. Real differences in costs arise from superior management, higher productivity and better disposition and utilization of capital. The accidental differences result from the failure of manufacturers to include in cost records all of the proper and legitimate items of expense. The most frequent accidental difference in costs is found where depreciation is not charged into costs or is left to be charged to profits at the end of the year.

The Chamber of Commerce of the United States says:

> The business man who does not charge depreciation at all is fooling himself. He is making no provision for the inevitable day when his property must be scrapped. His supposed profits may be in fact a distribution of his capital.
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> The business man who waits until the end of the year to determine his depreciation according to the size of his profits may make the discovery that he has no profits, since he has consistently sold his product upon a cost that was incorrect, a cost that

[1] Controller, Stutz Motor Car Co. of America, Indianapolis.

did not include such a necessary expense of manufacture as depreciation.

If an organization such as the Chamber of Commerce of the United States can make such a statement, there must be ample grounds for the contention that depreciation is a charge which should be applied to the product.

The answer to the question, What is depreciation? is economic. In the case referred to in my story, the depreciation charge represented the loss in value of the leasehold. The 10-year lease represented the real purchase, for the device involved in the transaction will last for 30 years if given the necessary maintenance. The annual cost of this charge was ascertained by dividing the purchase price, $15,000, by the 10 years the lease would run. As this firm had decided to operate on the calendar basis, the yearly charge was spread in 12 monthly installments, the business of each month bearing an equal portion of the yearly charge.

In depreciating the value of leases and patents, the procedure used in the case cited is customary, but I shall confine my remarks to depreciation of plant and equipment only.

A plant and the necessary equipment to produce a given product was provided originally by the investment of capital in the business. That plant and its equipment may have cost but $10,000 or it may represent $10,000,000. When that plant was purchased it was set up on the books of the company as a capital expenditure. It represents a considerable portion of the money necessary to the existence of the organization. Such capital expenditures or working assets are gradually dissipated through wear or obsolescence. They are, in fact, used up in production.

Depreciation is the decline in the value of plant and equipment which is certain to occur as a result of wear and tear and gradual obsolescence. It is caused by the possession and use of an asset, and is therefore a part of the cost of production. One writer has very aptly expressed it by saying: "All machinery is on an irresistible march to the junk heap"; and another writer defines depreciation as follows:

> Depreciation attempts to measure the effect of time and production on physical properties and equipment and to record the results in dollars and cents. This computation cannot be exact, because the elements affecting depreciation are many and their relative importance is difficult to determine. The use and character of property, its maintenance, the quality of installation, and local conditions, variously modify the life of property, while an unexpected industrial advance may suddenly terminate the usefulness of property and completely upset depreciation calculations.
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> One fact concerning depreciation is certain; it can be postponed but not ultimately avoided. All plants and equipment suffer from, and finally succumb to, depreciation.

L. A. BARON

Each turn of a lathe, every twist of a drill and each blow of a hammer helps to wear out plant and equipment. Depreciation continues, even though the plant remains idle. Each item produced, which causes this wear, should bear its proportionate share of depreciation costs.

DETERMINATION OF DEPRECIATION

The accountant, by accounting for depreciation, attempts to recover this loss in the value of the capital assets by charging it into the cost of production. This cost must be collected as the product is sold. The big question before the accountant and the cost man is the amount of depreciation to charge and how to charge it properly.

How long will a piece of equipment last? How much will it produce? Can it be used for 10 years, or will new and better equipment replace it within 5 years? The test for depreciation is how long the property will function, or how many units it will produce before scrapping time. In other words: *What is the expected useful economic life of a plant or a piece of equipment?* This is a question for an engineer to decide.

Determination of depreciation should not be a "guesstimate"; rather, it should be a painstaking, intelligent estimate backed by the experience of the estimator and the trade in general. There is no standard rate of depreciation for all businesses or for like equipment used in the same line of business. The character and type of property, its installation, its use or abuse, its climatic environment, its manitenance and the frequency and extent of its repairs are constantly varying in specific plants of the same industries. Standard rates for an industry are a great help, but such rates should be tempered by good judgment backed by experience.

I shall quote again from one of the bulletins of the Chamber of Commerce of the United States, as follows:

> INDUSTRIES SHOULD ESTABLISH DEPRECIATION RATES
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> Each industry, with the aid of its technical men, should establish for itself standard rates of depreciation, which rates should be set up on defined conditions and after agreement as to the line separating repairs from renewals. Tables of depreciation built up from group experience can be accepted as indicating the normal, customary and usual depreciation. They are, however, not designed to meet all contingencies or to take the place of private judgment. It is expected that adjustments of these normal rates either upward or downward will be made to suit the individual requirements. In the last analysis, the individual must determine his own depreciation allowance.

In my efforts to ascertain what had been done along this line in the automotive industry, I made inquiries of the Treasury Department at Washington. The Commissioner of Internal Revenue advised me under date of Oct. 3, 1928, that,

> An engineer of this office is at present engaged in the study of depreciation of plant and equipment used in the manufacture of automobiles. Results may be expected in six or eight months. The conclusions of this office will then be submitted to all automobile manufacturers for comment and criticism, with a view to agreeing upon and publishing mutually satisfactory standard rates of depreciation. . . .
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> With respect to depreciation studies which this office conducts with the voluntary cooperation of the industries concerned, at present over 60 of these cooperative studies are being conducted by National associations of industries, with the advice of and in cooperation with the Bureau of Internal Revenue. At present, the depreciation study in the automobile industry is the only one being conducted by representatives of the Bureau.

It certainly is regrettable to wake up to a situation such as this. With all the wonderful progress shown in our own industry, we must face the fact that we have failed in the matter of uniform accounting procedure. This is not the fault of the accountants of the industry. The men who come under the classification of "management" should have provided the necessary means for accountants to get together and work out this problem before it was taken in hand by the Government. Our lack of interest in this matter may react to our own disadvantage, as Government engineers will be prone to look upon our problems from the standpoint of tax revenue. I make this statement from experience. As recently as Oct. 23 I was called upon by an income-tax auditor to explain and prove an item of depreciation and obsolescence. The attitude of this man was representative of that of the tax division as a whole. These men are governed by regulations. The item in question was not covered in the regulations; therefore, it had to be proved. If the automotive industry had voluntarily taken up the study of depreciation, the findings of such a study might have been accepted by the Bureau of Internal Revenue and have become a part of the regulations which guide the income-tax auditors.

It should be a function of management to determine and to set the rates of depreciation and the method of apportionment. These rates should be based on normal production. By "normal," I do not mean average. Normal is the 100-deg. mark, above which the organization registers in times of unusual or excessive production and below which it drops in times of curtailed production.

Conservatism Needed

By all means be conservative when determining the useful life of a piece of property. It is much safer to have the property outlive the estimated life that was placed upon it than to have its usefulness terminate before its cost has been written off.

One authority on depreciation uses an 8-hr. day as normal time and adds a percentage to this depreciation for each hour a piece of equipment is working in excess of 8 hr. For a 9-hr. day he adds 5 per cent to the normal rate; for a 12-hr. day, 20 per cent; for a 16-hr. day, 50 per cent; and for a 24-hr. day, 150 per cent. This authority qualifies his charts with the following statement:

> We feel that, in fairness to all, after a normal rate of depreciation has been established, the allowance for overtime depreciation should exclude the element of obsolescence. This would mean that the allowance for overtime depreciation up to a certain point would not increase in the same ratio as the number of hours. In other words, we consider that the factor of obsolescence would be constant, and the only varying element would be the actual depreciation due to wear and tear. The "certain point" referred to should be 16 hr. After this point, we consider that depreciation takes place very rapidly and we feel that, in the percentages stated, the conditions are truly presented.

Method of Calculation and Application

Having established a reasonable useful economic life for each class of plant or equipment, it is necessary to determine a method of calculating the costs and applying the results to production.

The most common method used is the "straight-line" method; that is, the original cost, minus resale value, divided by term of useful life, gives the periodic charge. The simplicity of this method recommends it to many. Under some conditions and for certain classes of equipment, it is the ideal method. It is especially adapted for the depreciation of buildings, heating equipment, sprinkler systems, water tanks and many other similar items necessary to a plant. Other methods are known as reducing balance, sinking fund, annuity, and production. Each of these methods has its own value and can be applied wherever desired. Management's Handbook, edited by L. P. Alford and published by the Ronald Press, gives an adequate description of these methods of calculating depreciation.

Roy B. Kester, in his Accounting Theory and Practice, divides the different methods of apportioning depreciation under four headings: (*a*) proportional methods; (*b*) variable-percentage methods; (*c*) compound-interest methods; and (*d*) miscellaneous methods. Under proportional methods he lists the straight-line method, the working-hours method and the service-output method. These are the three methods most commonly used. The ease of application and lack of complicated formulas make them applicable to almost all lines of manufacturing.

I have already outlined the manner of applying the straight-line method. The working-hour method and the service-output method are very similar in application. One is based on the number of working hours that can be expected from a piece of equipment; the other, on the quantity of output from a piece of equipment or group of machines.

Proper Depreciation Apportionment

The accounting procedure necessary properly to apportion depreciation to production will depend in a great measure upon the variety of articles produced in a plant. If the plant is producing one item only, such as automobiles, depreciation can be applied to the product in a very simple and effective way. If the product is varied, the accounting procedure necessary properly to apply depreciation charges to the product will necessarily be more complicated.

When the Chamber of Commerce of the United States

was preparing a pamphlet on Overhead Accounting, it sent out many inquiries to its membership asking for suggestions. One of the members replied in part as follows:

> My suggestion is that you confine yourself to advising the installation of cost systems which will tie in with the general books. Anything beyond this is so technical and the application varies so greatly in different lines of business that it is hardly worthwhile to cover it in a general pamphlet. Someone who read it might get the idea that he knew something about cost accounting and could install his own system.

For the same reason I shall not go into a long discourse on the accounting procedure necessary to apply depreciation charges to the product.

Permanent Record of All Assets

Good accounting-practice is based on sound business policies, and it always is considered a sound business policy to keep a permanent record of all assets. The accountant uses this list of assets as a "plant ledger," or "property ledger," and it forms the basis for his depreciation charges. Such a property ledger will tie up with the general books of account and will supply the detail for the total cost of property, the depreciation written off in any one year, the additions, renewals and disposition of property, the amount in the depreciation reserves, the estimated scrap value, and the net remaining sound value of property. A complete record and history of depreciation as well as of plant and equipment can be secured through this ledger, which aims to do for plant and equipment what the perpetual-inventory record does for stock on hand.

In addition, the property ledger will contain a brief description of all property, where located, plant identification, name of the manufacturer and the manufacturer's number, from whom and when purchased, the total cost including freight and installation charges, the estimated useful life of equipment and rates of depreciation, and a tabulation of the periodic depreciation-charge against each item or class of items.

The property ledger can be compiled conveniently in card or loose-leaf form. The complete financial plant-history and performance-history of each item of property secured in this way guides future outlays upon plant, helps in the accurate determination of loss or gain on specific assets, is of some importance in credit applications, simplifies the compiling and checking of tax and annual statements, and is invaluable in the event of a fire loss.

Proper Classification a Necessity

A suitable classification of property is a prerequisite for the proper recording of depreciation. Do not make the mistake of grouping assets under such general terms as "Buildings," "Machinery," or "Equipment." The term "Buildings" may include wood, concrete, steel or brick structures designed for heavy or for light use. The term "Machinery" may comprise electrical generators and steam engines, hydraulic presses and steam hammers, lathes, planers, boring and milling-machines, wood-working machinery and small tools. "Equipment" may vary from a locomotive to pickling tanks, from gas furnaces to fire systems. The span of usefulness of these assets may vary from 3 to 33 years, yet all will bear a 3-per cent, 5-per cent or 10-per cent rate of depreciation; nor will it be possible to determine the depreciation record or history or the undepreciated value of any specific unit or type of property.

Tax regulations, as well as ordinary accounting expediency, require that the allowance for depreciation shall be computed and charged off with express reference to specific items, units or groups of property, each item or unit being considered separately or included specifically in a group with others to which the same factors apply. Hence, a correct record of depreciation requires that the specific items and units of property be enumerated and classified by kind, group or department, and that their original cost be ascertained, as well as the accumulated depreciation and the remaining useful life.

With a property ledger properly set up, an accountant is in a position to account for depreciation charges and to apportion depreciation to production. The periodical amount of depreciation should be set up as a charge in the operating expenses of the business, and a like amount representing the reserve for depreciation should be set up to replace the depreciated items.

Distributing Depreciation to Production

The whole theory of accounting for depreciation is to maintain intact the value of the original capital invested. It therefore becomes necessary in the accounting procedure to retain in the business, either in a specific or a floating form, the loss to capital caused by the depreciation of the assets. The accounting should be done in a manner which will assure the retention in the business of the original capital investment. This accounting procedure should be so definite that it will eliminate any possibility of this depreciation reserve being considered as a profit.

Depreciation as a production charge becomes one of the elements in overhead or burden cost, and it should be distributed to the product in the same way as the other items of overhead or burden are distributed.

As many methods are in use for distributing burden to production as there are methods of apportioning depreciation. The method that is meeting with the greatest favor is the "production-center" or "machine-center" plan. This calls for the grouping of equipment into production centers or units such as drill-press centers, punch-press centers, and lathe centers, automatic centers; or, in cases in which line production exists, it would be termed an assembly-line center, or a production-line center such as a cylinder-head line, cylinder-block line and the like.

When this method is used, the depreciation of buildings usually is applied to the center on the basis of floor space occupied. The center is also charged with the depreciation on all of the equipment used within that space. These depreciation charges, together with other overhead or burden charges, should be applied to the product of the production center on the unit basis or a standard-time basis, or on a percentage-of-labor plan.

To predetermine the actual economic useful life of any plant or piece of equipment is an impossibility. This fact is brought to light many times when accounting for depreciation. There are always items which depreciate much faster than is expected. Likewise, many items will be in use after their value has been written off the books. When new equipment is purchased to replace equipment that has outlived its expectancy, burden costs for producing the same items immediately

go up. The problem of how to handle such a situation comes up sooner or later in every organization that is accounting for its depreciation.

The usual procedure is to charge to current production the under-absorbed depreciation on those pieces of equipment which fail to last out their expected useful life, and to stop taking depreciation on that equipment which outlives its expectancy. When this procedure is followed, one period of operation is forced to bear an excessive charge for depreciation and the product in later periods bears no depreciation. Such procedure leads to fluctuations in cost figures that can very easily be avoided by setting up an over and an under-absorbed depreciation account. To this account one would charge the under-absorbed depreciation on the equipment which failed to meet its expected useful life, and the same account would be credited with a normal depreciation rate on all equipment which lasted longer than its expected useful life. Such a method of accounting would give an even charge for depreciation in all periods and would do away with some of the fluctuating cost-figures that appear in some plants that are producing with equipment which has outlived its expectancy.

Jigs and Fixtures a Separate Account

Depreciation for jigs and fixtures should not be confused with machine-tool depreciation. A jig or a fixture is made for the production of a specific item, while a machine-tool may be purchased for the production of a specific item but usually can be used for the production of other items. A jig or a fixture should be depreciated as quickly as possible, consistent with good practice. In other words, if it is the intention to product 100,000 of a specific item, and it is necessary to build a special jig or fixture to produce that item, such jig or fixture should be depreciated during the production for which it was designed.

Depreciation on Original or Replacement Cost?

In the current literature on the question of depreciation, some contend that depreciation should be based on cost to replace and not on the original cost. Agitation of this question seems to be stirred up by two separate schools or groups, each having a different axe to grind. On one side is the professional appraiser, who is advocating this system in the hope of promoting his own interests. The other group seems to be composed of a certain class of manufacturers who built extensive plants during war-time peak-prices. This latter group is now confronted with a troublesome question. Its members contend that, if they charge depreciation on the original cost of their plant, they cannot compete with other producers who were fortunate enough to build plants at times when the buying power of the dollar was greater than during the war. They further contend that, if they appraise their plants at present prices and use such appraisal figures for depreciation-cost purposes, they will fail to recover through their depreciation charge their original investment of capital in the plants.

The arguments along the foregoing line do not seem to me to coincide with good accounting-practice or with good management. I have been unable to locate any firm that is having trouble along this line. The Stutz Motor Car Co. made extensive additions to plant and equipment in 1919, when the buying power of the dollar was at the lowest point in more than 100 years. We are taking our depreciation on this original cost, and to date we have not found that it hampers us to the extent of being troublesome.

Many of those who are advocating that depreciation should be charged off at cost to replace are losing sight of the fact that for every dollar we spend today we are buying better equipment which will do our work much cheaper. Some will contend that this is not true in all industries, but I think that when we consider replacement value we must also take into consideration the service which we purchase with our replacement dollars.

Depreciation Reserve Becomes Working Capital

Contention is made that the depreciation charge should be such that it will allow a return of the value of capital invested, and that, unless depreciation is taken on a basis of replacement cost, the value of the capital invested will be greatly impaired. This would be true if the reserve set up for the replacement of depreciated items were allowed to remain idle. But such reserves do not remain idle; they usually become a part of the working capital and give a return equal to the earnings made on the balance of the working capital.

Earnings derived from the work of the depreciation reserve should not be passed out as dividends; they should be passed on to surplus, which later will be invested in better and more expensive equipment. This is the plan now followed by many of the largest and most successful manufacturing and industrial organizations.

If a person had buried $100 in gold coin in 1896 and were to dig it up in 1928, he would still have the $100, but its buying power would be approximately one-third of its former power. When money is put into a business it is not buried; it is put to work and is expected to receive compensation for the work performed. It is the compensation received for the work of depreciation reserves which should go to surplus for reinvestment in plant replacements.

Buildings and equipment should not be replaced in their former state, but with the thought of lessening production costs. Every replacement should be a plant betterment; then increased earnings will compensate for the increased cost of replacement.

Reserve Fund for Replacements

Question has also been raised as to the advisability of keeping the reserve for replacements in a separate fund for that express use. In some specific cases this may be not only desirable but highly advantageous. I am informed that in California a law exists which requires public utilities to keep such reserves available solely for the purpose of making replacements. If depreciation reserves are kept in a separate fund, it is doubtful if such a fund could be made to pay a greater rate of return than 4½ or 5 per cent net; but, if this same reserve were turned into the working capital, it should pay a much greater rate of return. I find that many firms are not definitely setting up a specific fund equal to the depreciation reserve, but do try to keep sufficient funds in the bank to make the replacements of capital assets which are necessary for current operations.

In trying to secure data along this line I enlisted the aid of the research department of the National

Association of Cost Accountants. This Association sent out for me a questionnaire to a selected list of its membership. All the replies received point to the contrary practice; none of the firms replying stated that a specific cash reserve is kept on hand for the purpose of replacing its plant and equipment.

In the Stutz Motor Car Co., which I represent, we use a very comprehensive system of budgeting which assures us of having sufficient funds on hand to replace our equipment when necessary. It is just as logical to budget the expenditures for plant replacements as to budget the labor or productive materials. A fundamental portion of any budget should be the financial forecast, which will set forth the probable financial position of the company at the end of each specific month or other period. Such a forecast will show all of the anticipated disbursements, and these naturally will include necessary replacements of plant and equipment.

Budget Should Include Replacement Expenditures

The successful operation of a manufacturing enterprise requires coordination of the four "Ms" of business: money, management, markets and men. Money provides the machinery and equipment necessary to produce the product. It is the duty of management to keep that machinery and equipment intact. This can be done by using a budget system which will inform management when it will become necessary to make expenditures for plant replacements.

Any plant that is operating on a budget which does not provide for replacement expenditures, should have the system revised into one which will provide for them; and any plant that is not operating on a budget should start one that will include the expenditures for replacements. Any budget plan should provide for the ordinary daily routine plant replacements or repairs. It is the large sums necessary for periodic replacements which the production man should foresee and have written into the budget. The production man in touch with conditions in his shop can foretell with considerable accuracy when specific machines will need to be replaced.

The production man who has successfully sold himself to his management rarely has trouble getting the necessary funds to keep his plant in first-class condition to carry out the production program forecast. It may be necessary to sell the management of a company on each replacement that is requested. If this is the case, the selling arguments should be marshaled before making the request. If the management cannot be convinced of the necessity for replacements, something is wrong with the salesman, the selling argument, or the management. If the so-called salesman fails to sell his idea, he should analyze his failure. It is possible for him to correct himself or his selling arguments. It will not be necessary to correct the management if it is wrong; either "money" or a bankruptcy court will do that.

Rules for Depreciation Charges

I shall conclude by quoting a few rules as a guide on depreciation charges, as follows:

(1) Be conservative in estimating the economical useful life of the plant and equipment.

(2) Set up your plant ledger not only for present use but as a guide for the future.

(3) Charge depreciation to the product.

(4) Collect that charge when the product is sold.

(5) Hold the funds so collected in a reserve, for plant replacement.

(6) Budget the cash expenditures so as to allow for replacement when necessary.

If you follow the foregoing rules, you need not worry about who gets what is paid for depreciation.

THE DISCUSSION

John Younger[2]:—Mr. Baron's paper is a valuable contribution to the economics of management. I note that he defines depreciation to include obsolescence, so that obsolescence is merely a factor of depreciation in its broad sense; but I am somewhat inclined to think that obsolescence should be treated specifically and distinctly, and be sharply differentiated from the other terms. This is particularly true today, when improvements in machine-tools are coming at a more rapid rate than that at which the tools wear out. The ideal situation occurs, of course, when obsolescence and ultimate depreciation take place simultaneously. Then only can one obtain the true economic usefulness of the machine. It seems to me that manufacturers today are striving for this goal, as they no longer "baby" their machines in a desire to prolong their life; rather, they drive their machines as hard as possible so that they can arrive at the new-model replacement.

One of the problems in the science of depreciation that has always bothered me is the cost of overhaul. Consider that a certain machine wears to a stage at which an extensive overhaul is demanded. After the overhaul, the machine is as good as it originally was. Should the cost of the overhaul be taken from the depreciation fund or from a maintenance fund? I incline toward taking it from the depreciation fund.

It always has seemed to me that depreciation is a justifiable charge. Every job done on a machine wears some part of the machine, and it is only fair to charge the customer for it. I am also in complete sympathy with Mr. Baron's attitude when he states that such money should be set aside in a special fund reserved for replacements, probably to be used for working capital but not spent in dividends.

I am under the impression that Scottish manufacturers follow this principle in their accounting systems. It is surprising that a splendid theory should be followed so little in practice.

L. A. Baron:—As to whether renewals should be taken from a maintenance fund or from the depreciation reserve, a very distinct line should be drawn in any plant as to what constitutes repairs and what constitutes a renewal. For instance, consider an engine lathe that has been in use for years. Its bearings have worn out and it has become necessary to install a complete new set of bearings and perhaps to renew the back gears. But that makes the lathe as good as it ever was, and it will be serviceable for years; so, the change con-

[2] M.S.A.E.—President and editor, Automotive Abstracts Co., Inc., Columbus, Ohio.

stitutes a renewal and the cost should be taken from the depreciation reserve. If, however, a leg of that lathe is broken the next day, its replacement would constitute a repair, and the cost should be charged to maintenance and should come under the heading of current expense of repair.

Public accountants, in auditing the books of some companies, find that the correct accounting procedure was not followed when different pieces of machinery were renewed. They find many cases in which the depreciation reserve equals the amount of money invested in plant and equipment; but still the plant and equipment are there and are giving service. This indicates that all renewals were charged to repairs.

Let us assume that a piece of equipment has an estimated life of 10 years and has received rough wear, but that after it has been used for 6 years it is proposed to spend $500 on a general overhaul. That $500 should be taken out of the depreciation reserve, put back into the plant-and-equipment account, and the estimated life of that piece of equipment should be recalculated. It can be assumed that it will then give service for say 9 years more. New depreciation ratios should be set for the renewed life of such renewed equipment.

Cellulose in Industry

WE have gradually and almost unconsciously passed over, industrially at least, in this Country to a new age in chemistry, the Age of Cellulose. There are three elements in cellulose: carbon, hydrogen and oxygen. When we chemists write the formula of cellulose we do a peculiar thing. We put a 6 after the carbon, representing six atoms of carbon; put 10 after the hydrogen, representing ten atoms of hydrogen; and 5 after the oxygen, for five atoms of oxygen. Then what do we do? We put parentheses around that formula and write a letter *n*, which means that it may be any multiple, and the textbooks usually say it is around 300 or 500 times $C_6H_{10}O_5$.

Cellulose constitutes virtually the earliest chemical factory in the world. Before men existed on earth, before animals existed, back in the plant period, through the energy of the sunlight, through the water of the soil, and the carbon dioxide of the air, under the influence of the chlorophyl in the leaves, there grew great forests. We find in cellulose a tendency to form long strings and adapt itself to the formation of the trunks of our trees and the stalks of our crops, like wheat, oats, rye and barley. It is under the action of sunlight that this happens. We all are anxiously looking all the time for means of increasing our National wealth. Today the greatest freely given wealth is the energy of the sun.

Cellulose is used in its natural state in the lumber industry, with a capitalization of $3,369,000,000; in the cotton-textile industry (the little fibers in the cotton are the purest form of cellulose we know in nature), $2,500,000,000; and the paper industry, with a capitalization of $1,336,000,000.

An industry of great National significance is the lacquer industry. I suppose no industry has ever gone through such a sudden revolution as has the industry of varnishing, and particularly does that apply to automobiles. The cellulose-lacquer industry is growing by leaps and bounds today; we know not what may come tomorrow.

Natural Fiber Industries Threatened

A very striking development in the use of cellulose, and one which is going to have great economic significance, is the development of the wonderful new fiber, rayon, or artificial silk. The production of rayon for 1928 passed 100,000,000 lb. From plant extensions already contracted for and new plants going up, the output of rayon for this Country for this year is estimated at 140,000,000 lb.

Cellulose, from either cotton or wood, is reduced to a form in which it can be projected from small openings, the solvent quickly evaporated, the thread of cellulose then twisted into larger threads, and woven into the beautiful garments we see today.

The chemist is going Nature one better. Here we have a fiber that is infinite in length. So long as we have the juice to keep squirting through the hole, we do not have to bother about length; whereas we used to make a great difference in the price between long and short-staple cotton. A few weeks ago the announcement was made that a new artificial silk has been produced which is stronger than natural silk and more resistant to water, and that the silk-thread people have taken the entire output. I do not hesitate to make the prediction that, before many years go by, natural silk is going to be doomed; and I will also make the prediction that before many years have elapsed our cotton planters will have a real economic problem on their hands.

If the cotton farmer says that he cannot produce cotton for less than 20 cents per lb. and make a living, how is he going to compete with wood pulp which is being sold readily at 10 cents per lb., when people are getting fabrics they prefer to cotton? There is a partial answer to the question. He has got to get busy on his cottonseed, which is not beginning to bring anything like its value today.

Opens Way to New Industries

We know that it is easy to convert cellulose directly into sugar; that it is being done. It is not quite economic at present; that is a question of research. We know that that sugar can easily be fermented into alcohol. The production of industrial alcohol has increased enormously within the last 10 years.

Sponsler, of California, is studying the X-ray picture given by cellulose. He has been able to work out the configuration of the molecule in a way that is extremely interesting, because it conforms closely to studies made in other ways. What may we not expect in the utilization of cellulose if we once get a clear, accurate picture of just how that molecule is made up? We have just as much right to expect an infinite number of new industries, that no chemist dreams of today, to develop out of cellulose as from coal tar.

The time will come when we shall make better and better use of the God-given sunlight as a great National source of wealth. The question will be asked: Where is all this cellulose coming from in the future? Red spruce and white spruce at 30 years of age yield 0.4 of a ton of wood per acre per year; slash pine, 2.9 tons per acre. More than seven times as much cellulose will grow on an acre of land in southeast Georgia as will grow in Canada. If we take care of that timber and give it a chance, down there is going to be the natural source of the cellulose supply for the future. That great section in northern Florida and southeast Georgia has a forest coming up by natural reproduction, where their big problem is to thin out the young trees.—Charles Holmes Herby.

Idiosyncrasies of Valve Mechanisms and Their Causes

By FERDINAND JEHLE[1] AND W. R. SPILLER[2]

ANNUAL MEETING PAPER *Illustrated with* PHOTOGRAPHS, DIAGRAMS AND CHARTS

AFTER mentioning the detrimental effects of valve bouncing and valve-spring surge upon the power and durability of an engine and on noise, the authors list four factors that contribute to perfect action of the valve mechanism. These are: the spring forces, as related to the speed and weight of the moving parts; the rigidity of the parts; the cam contour; and the design of the spring.

Four different methods of investigating valve behavior are then described in detail. The telescopic point-by-point indicator and the stroboscopic projector of the valve motion were the first of these to be developed. The former gives an accurate measure of the valve position at any point of the cycle, and the latter makes possible a visual inspection of the valve operation. These two instruments were used together, but they were found to be rather slow in operation.

The valve-lift-curve indicator, which was developed next, gives a photographic record of the valve-lift curve; and this was supplemented by a spring-vibration indicator which makes a record of the actual vibration of the spring on the same film with the valve-lift curve.

Spring surge is the direct result of resonance of the spring frequency with the harmonics of the valve-lift curve, according to the theory of the authors, which is checked experimentally. A formula, which includes both the harmonic analysis of the valve-lift curve and the characteristics of the spring, is given to aid in the selection of a good combination of spring and cam. Another formula is given for calculating the frequency of the spring in terms of its dimensions.

An outline for the procedure of selecting a good combination of spring and cam conclude the paper, the suggested order being: (*a*) harmonic analysis of the valve-lift curve; (*b*) determination of the spring frequency required to avoid resonance with bad harmonics; and (*c*) selection of the spring with reference to the limitations.

In an appendix are given a sample calculation of the harmonics of the cam and the mathematical derivation of the general equation for spring-vibration amplitude, as used in the paper.

THE effect on engine performance of the misbehavior of the valve mechanism is threefold, resulting in loss of power, breakage and wear of parts, and noise. The nature and extent of all three effects depend only on how closely the valve follows the lift diagram laid out for it. This diagram is assumed to be correct; that is, its area is large enough and the timing is such as to result in the desired engine-performance. Any discussion of valve timing and valve areas is, therefore, not within the scope of this paper.

Valve bouncing will affect power in several ways: It can bring about a late closure, or even a reopening, of the exhaust-valve, which causes a serious overlapping with the inlet; it can bring about a late closure, or a reopening, of the inlet-valve, which will result in some of the charge being backed out; or the bounce may occur while the valve is supposed to be open, in which case it increases the opening area and will not be detrimental to the power.

Breakage and wear of parts can be caused in two ways: by bouncing of the valve and by surging of the spring. Bouncing usually causes high valve-closing velocity and heavy impact on the seat, resulting in seat and valve wear. If the bounce occurs while the valve is open, the entire valve-operating mechanism may be overloaded. Spring surge usually results in overstressing the spring and increasing enormously the number of stress cycles, with a consequent fatigue break of the spring, followed perhaps by breakage of other parts.

[1] M.S.A.E.—Research engineer, White Motor Co., Cleveland.
[2] M.S.A.E.—Laboratory engineer, White Motor Co., Cleveland.

Noise, the least important result, is also caused by bouncing of the valve and surging of the spring. The former produces valve clatter, and the latter produces spring hum and coil clash.

CAUSES OF FAULTY ACTION

If a valve mechanism does not follow the lift curve, it is because the different factors having to do with valve performance are not properly balanced. These factors are as follows:

(1) The spring force, as related to speed and weight of the moving parts
(2) Rigidity of the parts
(3) Cam contour
(4) Design of the spring

The spring must be calculated to exert a force equal to that of the negative acceleration plus the friction of the mechanism at the maximum speed. This presents no special difficulty. The different parts entering into the valve mechanism, such as cam followers, push-rods and rocker-arms, must be so designed that they will possess the maximum rigidity with the minimum weight. This also is not difficult, but rigidity should never be sacrificed for lightness. Increased weight can be met with a stronger spring, but there is no such easy remedy for errors due to flimsiness of the parts.

Both the cam contour and the design of the spring are of great importance, and these will be dealt with later in the paper.

Study of valve behavior through its effect on engine performance is a long, tedious, cut-and-try method.

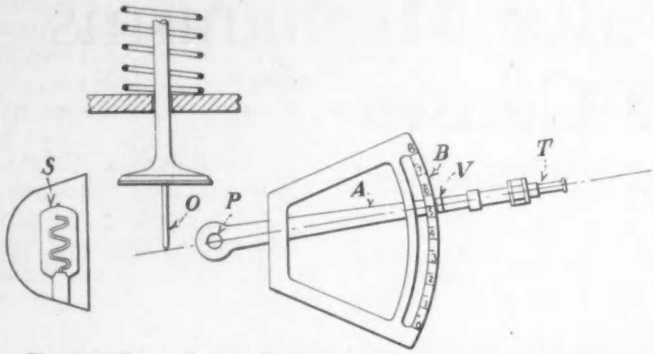


FIG. 1—DIAGRAM OF TELESCOPIC VALVE-LIFT INDICATOR

The valve motions should be studied directly. A certain amount of this can be done on an engine by observing the valve and spring motions with some sort of stroboscope, such as the Vibroscope. Engines, however, are not designed primarily to facilitate the observation of valve motions, and a special machine upon which the valve mechanism can be mounted is necessary for their complete analysis. We have built such a machine and developed instruments of four different types for studying valve motions. They are:

(1) Telescopic point-by-point indicator
(2) Stroboscopic projector of the valve motion
(3) Valve-lift-curve indicator
(4) Valve-lift-curve indicator with a spring-vibration indicator

Since each successive instrument did not exactly take the place of its predecessor, but was made for studying a different phase of valve operation, all four will be described.

TELESCOPIC POINT-BY-POINT INDICATOR

Fig. 1 is a schematic diagram of the telescopic point-by-point indicator, and Fig. 2 shows it in operation. A pointer, *O*, is attached to the valve. In front of the valve is mounted a telescope, *T*, in an arm, *A*, which is pivoted at *P*. Arm *A*, in revolving around its pivot, *P*, follows arc *B*, on which is engraved a scale. The arm, *A*, is provided with a vernier, *V*. The telescope is focused on the pointer *O*, and the angle can be read by means of vernier *V* and arc *B*. This angle can be translated into valve lift after a suitable calibration of the mechanism has been made.

In operation, the valve and its pointer are enclosed in a comparatively dark box and are observed at selected positions of the camshaft by means of stroboscopic illumination. The Vibroscope which was used for this purpose consists of a neon lamp operated through an induction coil and breaker. The breaker was attached to the camshaft, and it could be adjusted easily so that the light would be lit for an instant at any desired point of the camshaft revolution. The position of the neon bulb for illuminating pointer *O* is shown at *S*. The breaker for operating the neon lamp *S* is shown at *I*, in Fig. 2.

This apparatus is extremely accurate for measuring valve lift. As it is difficult, however, to obtain a preliminary idea of the valve action with this, it was decided to build a stroboscopic projector to be used in conjunction with the telescopic indicator for what might be called qualitative analysis of the valve motion. With this second device it was possible to watch the motion of the valve at reduced speed and enlarged scale so that the interesting speeds could be selected. The more accurate observations could then be made with the telescope at these speeds.

Fig. 3 is a schematic diagram and Fig. 4 a photograph showing the arrangement of this apparatus. Again *O* is a pointer attached to the valve; *L* is a source of light, such as a projection bulb or an arc lamp; *C* is a condenser lens; and *B* is an objective lens which focuses an image of pointer *O* on screen *S*. A stroboscopic disc, *D*, is placed between the objective *B* and the screen *S*, at what is called the neck of the beam. This disc has one opening to permit the light to pass; therefore, the image of *O* is thrown on the screen once for each revolution of the disc. If the disc were rotated at exactly the same speed as the camshaft which operates the valve, the image of pointer *O* on screen *S* would remain at rest. It was, however, rotated at a slightly lower speed than the camshaft, through the friction-disc variable-drive *U*, and the image on screen *S* moved at a proportionately low speed. As seen in Fig 4, it is not necessary to remove the telescope from the machine while using the screen. After making the qualitative study of the valve, the stroboscopic disc and screen can be moved out of the way easily and the telescope swung into its place for accurate readings.

VALVE-LIFT-CURVE INDICATOR

While the combination of these instruments gave good results, it was not possible with them to study valve performance with satisfactory speed. It was, therefore, decided to develop a valve-lift indicator that would project the valve-lift curve. The upper part of Fig. 5 is a schematic diagram of the mechanism for doing this, including the entire cam mechanism and the motor for running the camshaft. In many respects it is similar to the equipment shown in Figs. 3 and 4, as it is a projection lantern. The light is shown at *A*, the condenser lens at *B*, a small aperture at *C*, an objective lens at *D*, and a screen at *E*. These parts would project an image of the aperture *C*, which moves with the valve.

If, instead of letting the objective project the image directly upon screen *E*, it is deflected by means of a

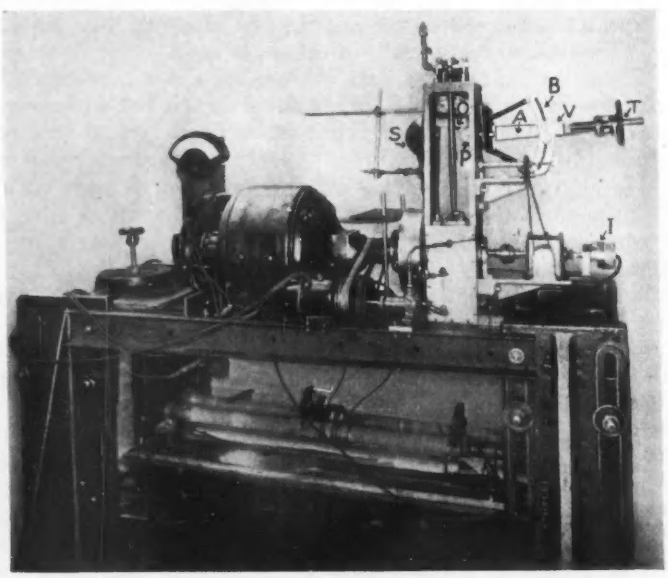


FIG. 2—PHOTOGRAPH OF TELESCOPIC VALVE-LIFT INDICATOR

plain mirror, F, set at the proper angle, upon a rotating mirror, G, the resultant of two motions is projected on the screen. The vertical component is obtained from the motion of the valve, and the horizontal component from the revolving of the mirror G. This mirror has eight sides and rotates at one-eighth camshaft speed. The image on screen E, therefore, will be repeated once for each camshaft revolution and, owing to the persistence of vision, appears to be continuous and stationary, in the shape of the ordinary valve-lift curve. This image curve can be observed visually for seat bouncing and increased lift, as with the stroboscopic projector; also, any irregularity of the opening and closing lines can be seen. When desired, a photographic film such as is used in the ordinary portable camera can be put in place of screen E, and the curve will be photographed. To photograph successfully, it was necessary that a mechanism be developed for holding the shutter open while only one projection of the valve lift passes across the film.

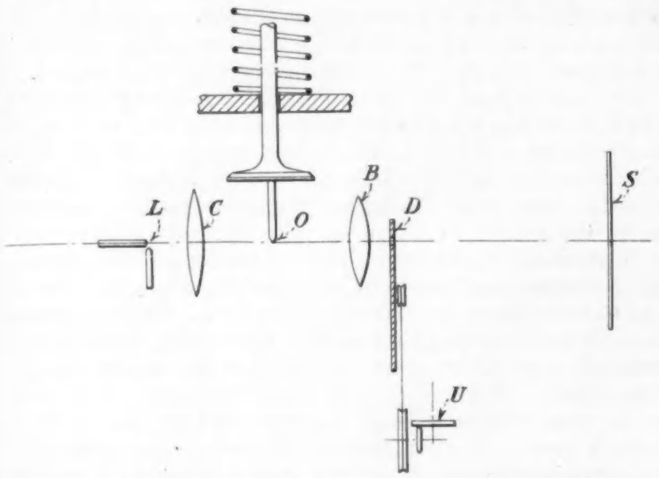


FIG. 3—DIAGRAM OF STROBOSCOPIC VALVE-MOTION PROJECTOR

The one trouble with this device was that the aperture C was magnified, as well as the motion of the valve, resulting in a heavy record line on the screen. To overcome this difficulty, we developed the apparatus shown in the lower portion of Fig. 5 to replace the plain aperture. This consists of an aperture, H, of about 1/32 in., and a strong negative lens, I, some distance away from it, both mounted in a support, J, attached to the valve. The result is that a reduced image of the aperture is used to draw the lift curve on the screen, and very thin record lines are possible. The weight of the valve must be reduced by an amount equal to the weight of the lens and its support, which must be kept at the minimum. Fig. 6 shows this valve-lift indicator complete, the parts being lettered to correspond with Fig. 5.

SPRING-VIBRATION INDICATOR

The spring-vibration indicator, shown on Figs. 7 and 8, is designed to project on the screen a stationary image of the wave motion of a coil of the spring. It is a part of the valve-lift indicator and uses the same projection system. By means of three small mirrors, A, B and C, a beam of light from the projection lamp is led around the valve, through a small slot, D, which is the object to be projected, and into the objective

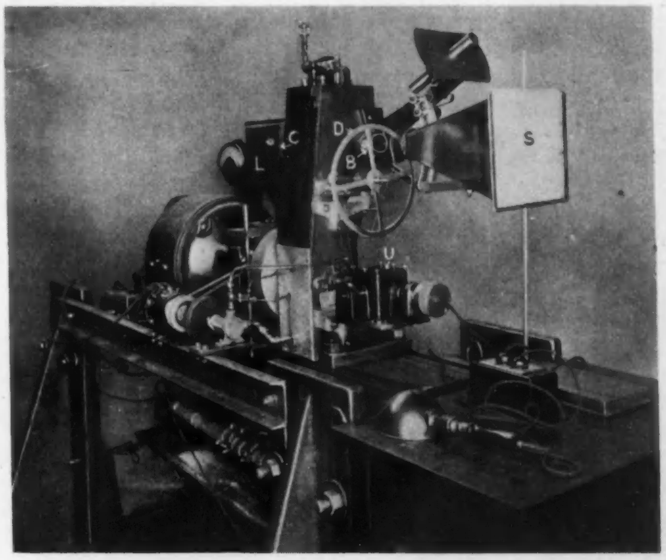


FIG. 4—PHOTOGRAPH OF THE STROBOSCOPIC VALVE-MOTION PROJECTOR

lens. As in the valve-lift indicator, the image of this slot is focused on the screen after being reflected by a 45-deg. flat mirror and an octagonal rotating mirror. For optical reasons, this image must be offset from the image of the aperture which makes the record of the valve motion, and correction made accordingly. In front of this slot, the width of which is adjustable, is placed a small shutter, E, which moves up and down with one of the coils of the valve-spring, F, and thereby

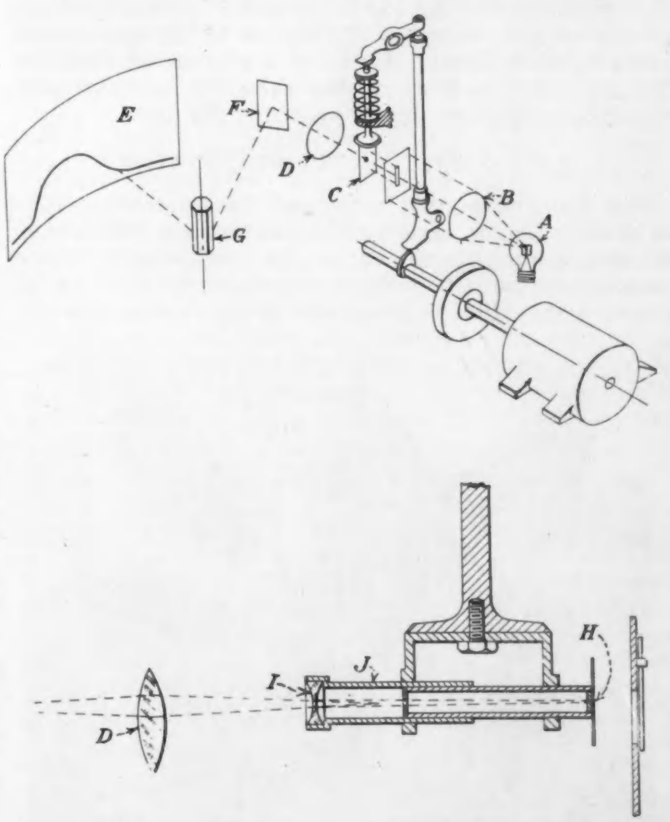


FIG. 5—(UPPER DIAGRAM) VALVE-TEST MACHINE WITH VALVE-LIFT INDICATOR. (LOWER DIAGRAM) IMPROVED OPTICAL SYSTEM OF VALVE-LIFT INDICATOR

changes the length of the slot and of the image on the screen accordingly. The shutter is attached to the spring coil by means of a piece of stiff wire, *G*, soldered to the coil and guided through a small hole, *H*. The valve lens, *I*, and its support, *J*, are the same as those designated by the same letters in Figs. 5 and 6, and *K* is the valve. The combination of the change in image length with the motion across the screen produced by the rotating mirror throws an enlarged picture of the coil motion on the screen. Since this picture is repeated by every face of the octagonal mirror, the persistence of vision makes it appear stationary, and the vibration can be studied carefully. For permanent record, this picture is thrown on a sensitized film, as in the valve-lift indicator.

It is realized that this method of studying spring vibrations has some disadvantages. The shutter wire which is attached to the spring coil has some weight and is subject to some friction in its guides, therefore it damps the spring vibration slightly. This may lower the frequency of vibration, but a measurement showed the change in frequency to be not greater than 5 per cent. It is also possible for the wire to superimpose a motion of its own on that of the spring coil and thus distort the resulting picture. Both these difficulties can be minimized by careful selection and installation of the wire.

On the other hand, this instrument shows and records the actual vibration of the spring coil on a scale large enough so that each movement of the coil can be studied. It shows the number of vibrations per cycle of valve lift, the intensity of vibration, the wave form and direction in relation to the valve lift, the dying out of the vibration during the valve-closed period, and, in general, the actual mode of vibration of the spring as a check against theory. Fig. 9 is a photograph showing the complete assembly of the valve-lift indicator and the spring-vibration indicator, ready for use.

Studies With Valve-Lift Indicators

The stroboscopic projector and the telescopic point-by-point indicator were always used together, the former for determining the speeds at which valve performance was not good and the latter for studying the diagram at these speeds. Comparisons were always made with the

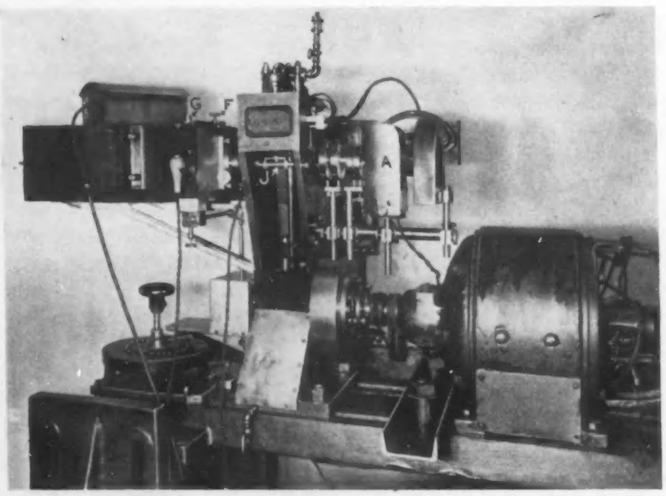


Fig. 6—Photograph of Machine with Valve-Lift Indicator

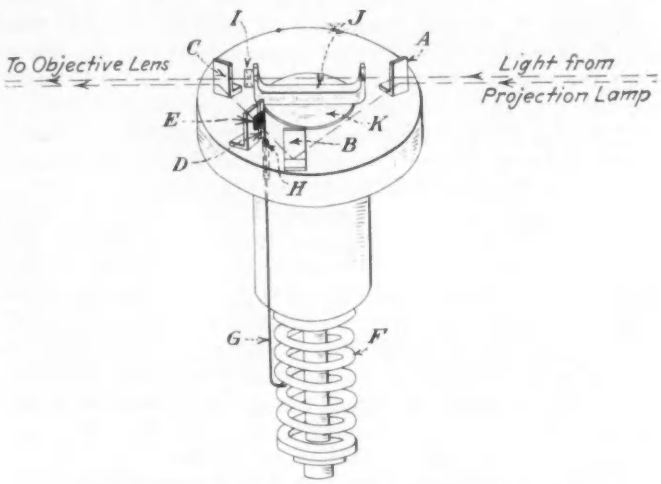


Fig. 7—Diagram of Spring-Vibration Indicator

lift curve at a camshaft speed of 200 r.p.m. Fig. 10 shows a curve plotted from the readings taken with the telescope. The fine line and open circles represent the lifts at 200-r.p.m. camshaft-speed. The heavy line and filled-in circles were taken from observations at a camshaft speed of 1130 r.p.m. A study of these two lift-diagrams shows that valve performance at this higher speed is very poor. Bouncing occurs on the cam as well as on the seat.

Results are much more easily obtained with the valve-lift indicator, and photographic records of the lift curve can be taken at a great variety of speeds. Fig. 11 shows the valve-lift curve at three different speeds, each superimposed on a lift curve for 200 r.p.m. of the camshaft. The upper record was taken at a camshaft speed of 1370 r.p.m. Severe bouncing on the cam and on the seat is seen. The measurements show that the height of the first bounce is approximately 0.027 in., and it extends over an angle of approximately 19 deg. The second bounce is not so high but is almost as long, and fluttering of the valve does not cease until approximately 68 deg. after the valve should be seated.

The middle record was taken at a camshaft speed of 1400 r.p.m. The curve for this speed does not depart appreciably from the 200-r.p.m. base-line. It represents a reasonably good valve-lift diagram. The lower record was taken at a camshaft speed of 1430 r.p.m., and again bad bounces are visible. The seat bounces are not so severe at this speed as those recorded in the upper record, but the bounces on the cam itself are worse.

Bouncing of any exhaust-valve to the extent shown in the upper and lower curves of Fig. 11 causes a serious overlapping, which results in a loss of power. When this power-loss occurs in the neighborhood of the maximum road-speed, it is more noticeable than when it occurs at a lower speed, although the resultant damage may be greater at the lower speed because it is within the range of normal driving.

Fig. 12 shows the valve-lift curves at speeds of 1200, 1000, and 780 r.p.m. of the camshaft, each superimposed on a 200-r.p.m base-line. These are rather good valve-lift curves and are, of course, at speeds in which our company is principally interested.

The causes of bad valve-performance seem to depend upon the spring characteristics in their relation to the cam characteristics. Whenever a valve bounces, either

on the cam or on the seat, the spring is too weak for the condition under which it is operating. If the spring simply is too weak to oppose the acceleration force such as is calculated from the ordinary valve-lift diagram, the bouncing will become worse as the speed increases. From Fig. 11 it is seen that a valve-lift curve may be better at a higher speed. The spring force in this case is, therefore, high enough to meet the ordinary cam-acceleration requirements, but for some reason was reduced temporarily. What is commonly known as spring surge seems to be the cause.

Spring surge—or, better, spring vibration—is a torsion wave transmitted through the wire so that the wave travels up and down the spring. To explain why a spring surges is more difficult. Authorities agree that the spring gets into resonance with a periodic motion of the engine, and the most likely of these periodic motions is that imparted by the camshaft to the other parts of the valve mechanism. There is no doubt that a state of resonance must exist; or, in other words, that the spring vibrates sympathetically. A simple explanation of the conditions required for a state of resonance, or sympathetic vibrations, can be found in an elementary textbook[3].

Before violent surging develops, the spring must be subjected to a periodic force having a period equal to the time taken for a wave to travel up and down the spring. This is the simplest type of spring vibration and causes the most severe surging. If the frequency of the driving force is twice as great, then the first overtone of the spring is excited, and a condition arises that is similar to a propagation of waves from both ends of the spring simultaneously. This results in the phenomenon of a "standing wave," with a node or stationary point at the center of the spring. In other words, the spring appears to vibrate in halves. In like manner, standing waves of higher frequencies can be produced, but they are of progressively less importance.

Calculation of the frequency of the spring seems,

[3] See A First Course in Physics, by R. A. Milliken and H. G. Gale; Ginn & Co.

[4] See *The Automobile Engineer*, August, 1926, p. 290.

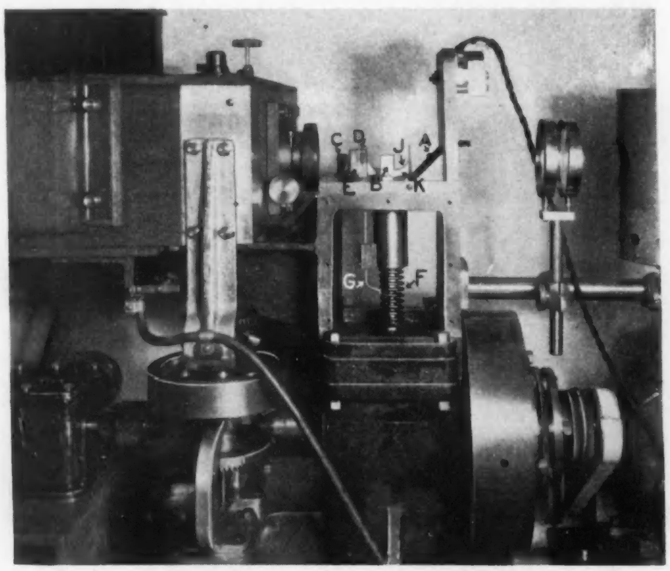


FIG. 8—PHOTOGRAPH OF SPRING-VIBRATION INDICATOR

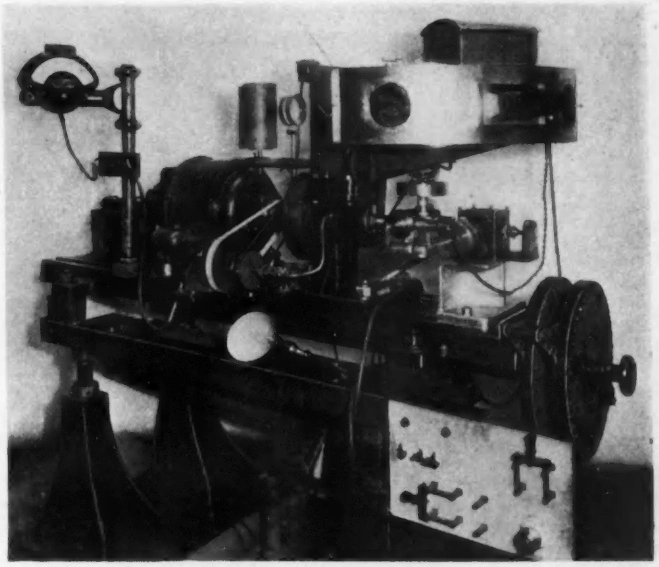


FIG. 9—COMPLETE MACHINE, WITH SPRING-VIBRATION INDICATOR IN PLACE

therefore, to be of the utmost importance in the design of a valve mechanism. A useful formula for determining the approximate frequency of a steel compression-spring in terms of its dimensions, derived from a formula in an article on Valve Springs, by Andrew Swan[4], is

$$F = 250\,(d \times \sqrt{G})/(D^2 \times N) \qquad (1)$$

in which F is the number of complete vibrations per minute; d is the diameter of the spring wire, in inches; G is the modulus of rigidity, 11,500,000 lb. per sq. in.; D is the mean diameter of the spring coil, in inches; and N is the number of active coils.

Disturbing Force

The only periodic force acting on the spring is that due to the periodic motion of the valve, that is, the valve lift. No engine speed is high enough so that the valve lift can ever come into resonance with the spring frequency. Any periodic motion such as the valve-lift curve, however, can be resolved into a series of harmonic components, which are sine curves of increasing frequencies. The ordinates of these sine curves, added together, equal the ordinates of the original valve-lift curve. When the order number of one of these harmonics multiplied by the camshaft speed in revolutions per minute is equal to the frequency of the spring, in vibrations per minute, a state of resonance results and surging occurs.

Fig. 13 shows the harmonics of a valve-lift curve from the eighth up to and including the thirtieth. The lower harmonics are as a rule of a much greater amplitude, but the speeds at which they would come into resonance with the spring are far above the usual camshaft speeds, therefore they were omitted to avoid obscuring the more significant curves. Table 1 shows the maximum amplitude and the sign of each harmonic of six different cam contours. The sign of these harmonics has been arbitrarily chosen as positive in the direction of valve lift and negative in the opposite direction. From Fig. 13 it is seen that these harmonics have widely different amplitudes. In general, the higher ones have a smaller amplitude than the lower ones, although this is not true

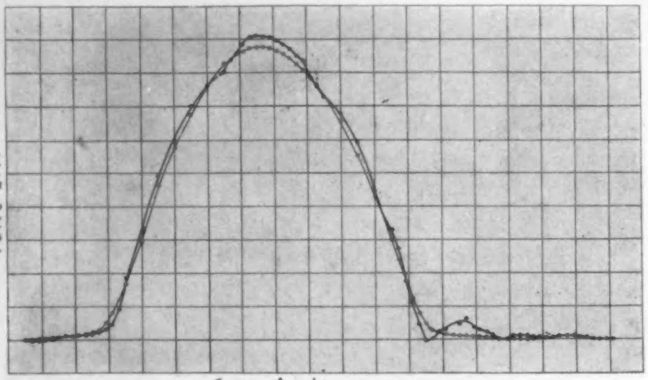


FIG. 10—VALVE DIAGRAM PLOTTED FROM POINT-BY-POINT READINGS

The Fine Line Represents Lifts as Observed with the Telescopic Indicator at a Camshaft Speed of 200 R.P.M. The Heavy Line Represents Observations at a Camshaft Speed of 1130 R.P.M., Showing the Bouncing of the Valve at This Speed

throughout. The ninth, for example, has an amplitude less than that of the fourteenth. The one thing they all have in common is that their maximum amplitude occurs in the center of the lift curve.

Plotting a chart, using for abscissa the order number of the harmonics and for ordinate their maximum amplitude, gives the peculiar curve shown in Fig. 14. This curve is that of a function alternating between positive and negative values and approaching zero from both sides. This is true of all the valve-lift curves we have analyzed, but we do not know whether it is true of all lift-curves, nor do we know the law that governs this curve. It is realized that the spring vibration is caused by a force and that, therefore, the harmonics of the valve acceleration rather than those of the displacement curve are responsible for it. For any one cam-and-spring combination, the acceleration and displacement harmonics are proportional, and the latter will therefore be used in the discussion immediately following. The derivation of acceleration harmonics, as well as a simplified form of harmonic analysis, is given in the appendix.

EXPERIMENTAL CHECK OF HARMONIC THEORY

A spring-and-valve combination that vibrated badly was chosen to check the harmonic theory. The cam contour is that shown as No. 1 in Table 1. As determined with the shutter wire attached, the spring had a frequency of 11,450 vibrations per minute. The calculated frequency of the spring was 11,800 vibrations per minute.

TABLE 1—MAXIMUM AMPLITUDE OF VALVE-LIFT HARMONICS FOR DIFFERENT CAMS, IN INCHES

Harmonic Order	Cam No. 1	Cam No. 2	Cam No. 3	Cam No. 4	Cam No. 5	Cam No. 6
1	+0.1586	+0.1324	+0.1476	+0.1476	+0.1484	+0.2838
2	+0.1008	+0.1056	+0.1342	+0.1119	+0.1150	+0.1088
3	+0.0634	+0.0604	+0.0715	+0.0746	+0.0735	+0.0504
4	+0.0265	+0.0222	+0.0174	+0.0295	+0.0353	+0.0213
5	+0.00186	—0.0039	—0.0020	+0.0052	+0.0064	+0.0038
6	—0.01054	—0.0121	—0.0141	—0.0099	—0.0070	—0.0121
7	—0.01117	—0.0102	—0.0122	—0.0120	—0.0108	—0.0085
8	—0.00512	—0.0031	—0.0044	—0.0064	—0.0064	—0.0034
9	+0.00093	+0.0036	+0.0024	+0.0002	—0.0004	+0.0019
10	+0.00418	+0.0043	+0.0045	+0.0038	+0.0027	+0.0040
11	+0.00372	+0.0022	+0.0028	+0.0042	+0.0030	+0.0027
12	+0.00078	—0.0009	—0.0005	+0.0018	+0.0014	+0.0006
13	—0.00140	—0.0026	—0.0021	—0.0006	—0.0002	—0.0016
14	—0.00201	—0.0020	—0.0019	—0.0019	—0.0009	—0.0019
15	—0.00140	—0.0003	—0.0008	—0.0015	—0.0007	—0.0012
16	+0.00046	+0.0011	+0.0008	—0.0002	—0.0003	—0.0002
17	+0.0011	+0.0011	+0.0014	+0.0009	+0.0003	+0.0010
18	+0.0011	—0.0002	+0.0009	+0.0011	+0.0002	+0.0008
19	+0.00062	—0.0006	0	+0.0008	+0.0001	+0.0004
20	—0.00015	—0.0009	—0.0004	+0.0001	0	—0.0002
21	—0.00062	—0.0005	—0.0002	—0.0002	—0.0003	
22	—0.00031	—0.0002	—0.0001	—0.0003	—0.0002	
23	+0.00031	+0.0005	+0.0002	—0.0001	—0.0001	
24	+0.00062	+0.0006	+0.0003	+0.0002	—0.0003	
25	+0.00046	+0.0002	—0.0001	+0.0002	—0.0003	
26	+0.00031	—0.0005	—0.0002	0	—0.0003	
27	0	—0.0005	0	0	—0.0001	
28	0	—0.0002	0	—0.0001	+0.0001	
29	+0.00015	+0.0002	+0.0001	0	+0.0002	
30	+0.00031	+0.0003	+0.0001	+0.0001	0	

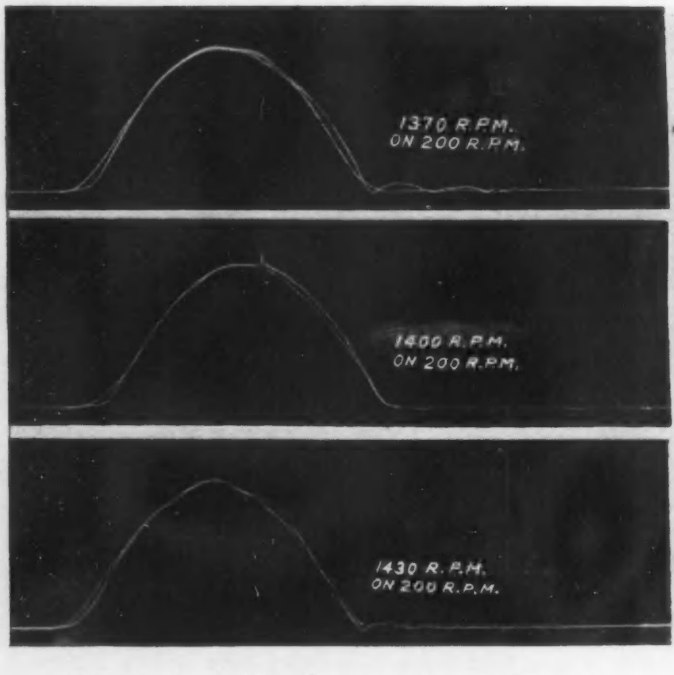


FIG. 11—VALVE-LIFT-INDICATOR CURVES SHOWING VALVE BOUNCING

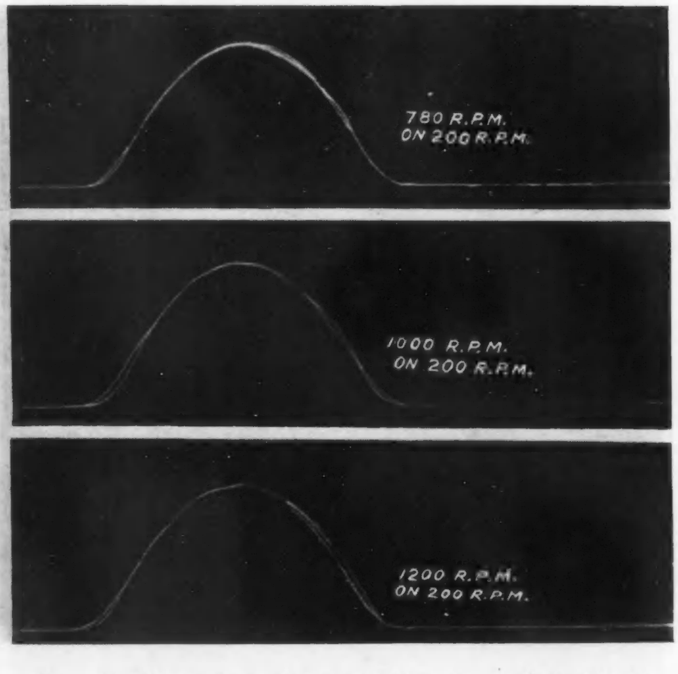


FIG. 12—VALVE-LIFT-INDICATOR CURVES AT CUSTOMARY ENGINE-SPEEDS

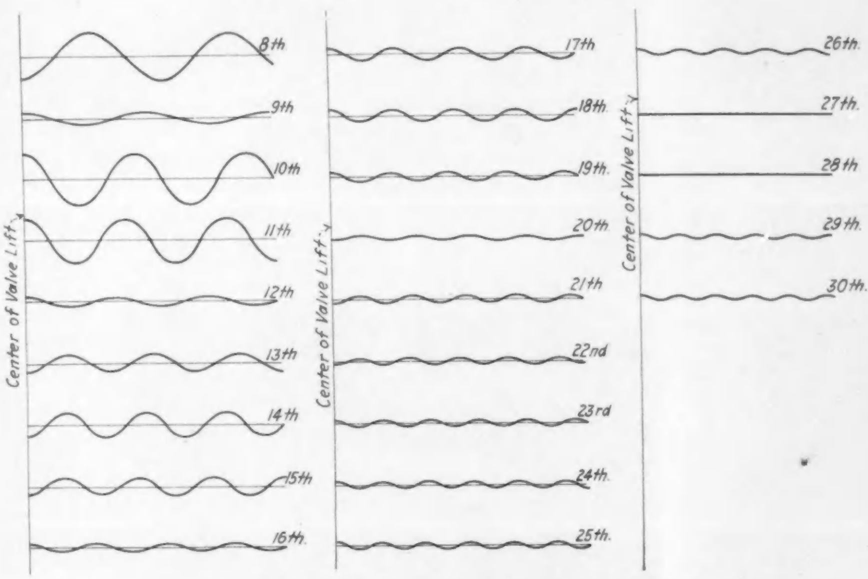


FIG. 13—HARMONICS OF VALVE-LIFT CURVE

Based on Cam No. 1, Table 1

Figs. 15 to 18, inclusive, show records of the spring vibration and valve-lift curve through a camshaft speed-range of 573 to 1050 r.p.m. The speeds at which photographs were made, except that at 850 r.p.m. in Fig. 17, are those at which the maximum vibration seemed to occur. If the number of spring waves on each record is multiplied by the speed at which it was taken, a number is obtained that is within less than 1 per cent of 11,450, the observed frequency of the spring. It appears, therefore, that the actuating force is the cam harmonic, the order of which is represented by the number of waves per camshaft revolution as shown on the records.

Inspection shows that the amplitudes of the waves on the records have the same general relation to one another as the amplitudes of the corresponding harmonics shown in Table 1, for cam No. 1, and in Fig. 13. The spring vibrations, therefore, correspond to the amplitudes of the harmonics of the lift curve.

There remain to be checked the phase and the sign of the waves. If the experimental work checks the calculations, the maximum amplitude of a spring wave must lie on the center line of the valve-lift curve and its sign must be that shown for the corresponding harmonic of cam No. 1 in Table 1. To check this, a correction must be made for the offset, as explained in the description of the valve-lift and spring-vibration indicator. In this case the offset was 0.5 in. in advance of the lift curve. In addition to this, a correction must be made for the time it takes a wave to travel from the end of the spring to the mid-point, one-quarter of the total wave length. This correction is in the direction of valve lift; that is, in the direction opposite to the correction for offset. The vertical line on each record shows the valve-lift center-line displaced to agree with these corrections. In every instance, the phase and the sign check with the calculated quantities.

In comparing the films for the different speeds, it will be seen that the middle one in Fig. 16, representing a speed of 717 r.p.m. and harmonic No. 16, is the lowest. That is correct, since the sixteenth harmonic is of a very low amplitude. The record which appears in the center of Fig. 17 is peculiar. There is no harmonic corresponding to 850 r.p.m., and this is verified by the record. As this speed is between the strong thirteenth and fourteenth harmonics, the spring probably is excited by these. It is not in phase with the speed of the camshaft, however, and it can be seen plainly that the vibration is damped by interference as soon as the valve lifts again.

The other record of special interest is the top one in Fig. 18, which represents a speed of 920 r.p.m. The result of dividing the frequency, that is 11,450, by 920 is 12.5. There can be no harmonic of this order, but Table 1 shows that this cam contour has a twenty-fifth harmonic of appreciable magnitude, and this harmonic is exciting the first overtone of the spring. No particular care was taken to attach the shutter wire to the exact mid-point of the spring, where the node exists in this type of vibration. Examination of the record discloses that the vibrations are double. This indicates that the shutter was not connected at the node and that the spring was vibrating in halves.

Careful measurement of the wave spacing of all the records reveals that the waves are closer together during the period of valve lift than while the valve is on its seat. This is to be expected when it is remembered that the number of active coils of the spring is somewhat less during valve lift than while the valve is closed; the spring has, therefore, a slightly higher frequency while the valve is open.

A spring that is actuated by a cam mechanism which produces one simple harmonic motion per revolution of the shaft cannot vibrate until the cam reaches a speed equal to the frequency of the spring. Such a speed is not obtainable with our apparatus; but a harmonic

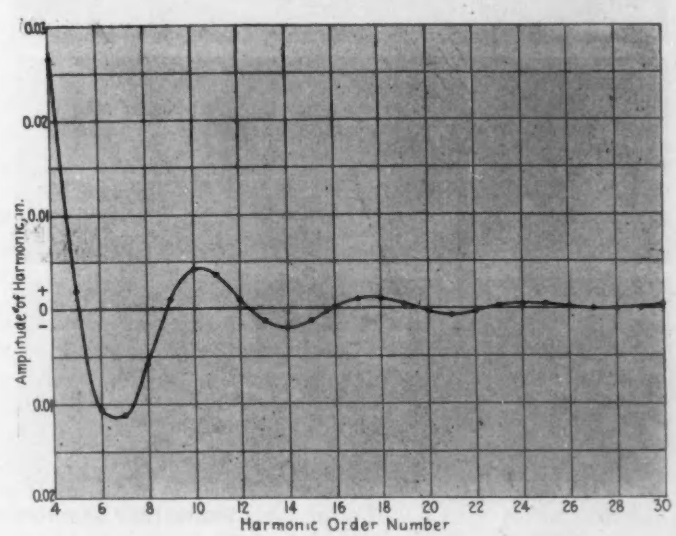


FIG. 14—RELATION BETWEEN AMPLITUDE AND ORDER NUMBER OF HARMONICS

Based on the Same Cam as Fig. 13

mechanism, consisting of an eccentric and mushroom follower, was used to operate the spring up to 1850 r.p.m. of the shaft and no vibration whatever occurred. Fig. 19 shows three films taken with this eccentric, at speeds of 250, 1000 and 1850 r.p.m. Spring vibrations are visible in none of them, and the three records exactly superimpose.

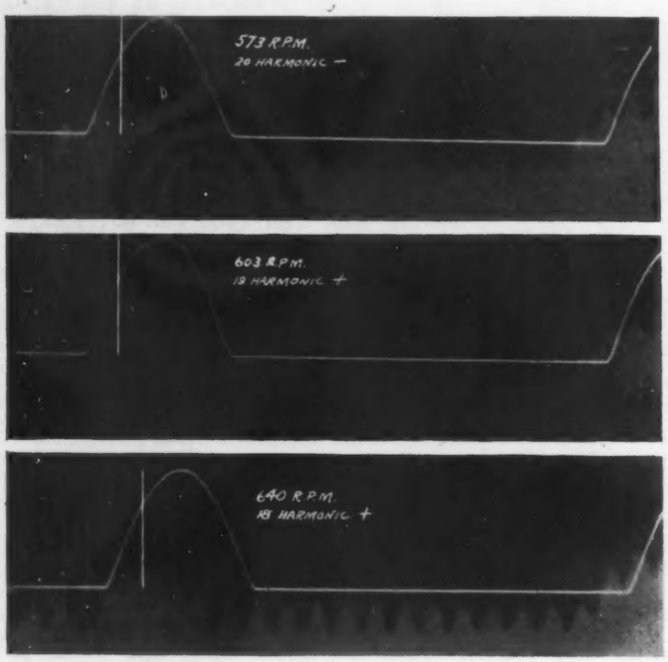
Results of experiments agree, therefore, with the theory that valve-spring surge is related directly to the harmonics of the valve-lift curve.

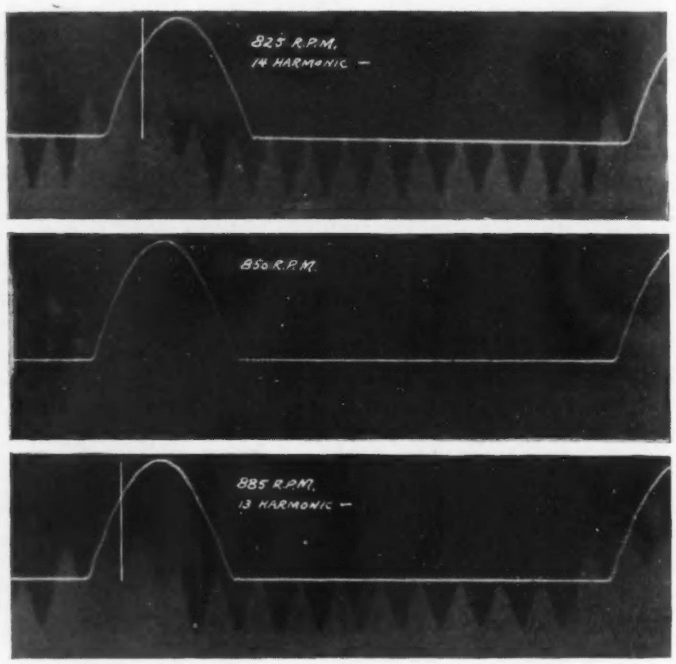
Selecting a Combination of Spring and Cam

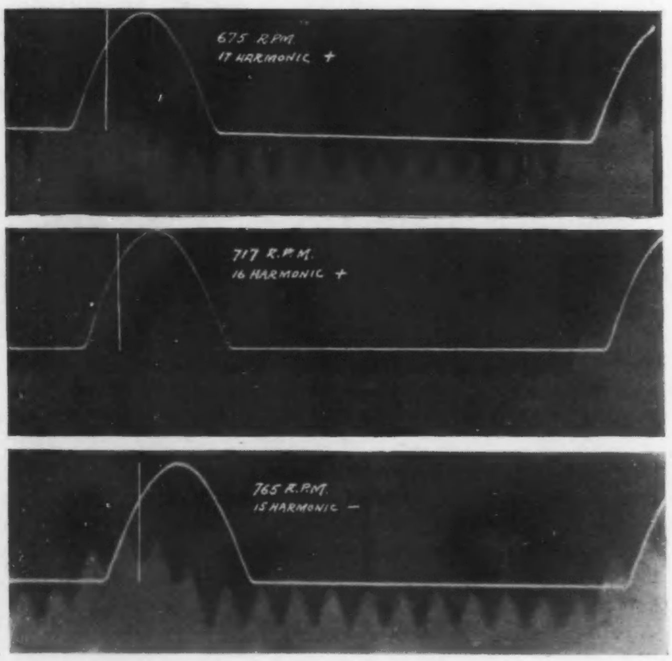
Up to the present, various writers have suggested different factors as influencing valve-spring vibration. Until all of these factors are known it is impossible to select a spring intelligently for minimum vibration. An attempt has been made, therefore, to collect these factors in a single equation, the derivation of which is given in the Appendix of this paper. This equation is

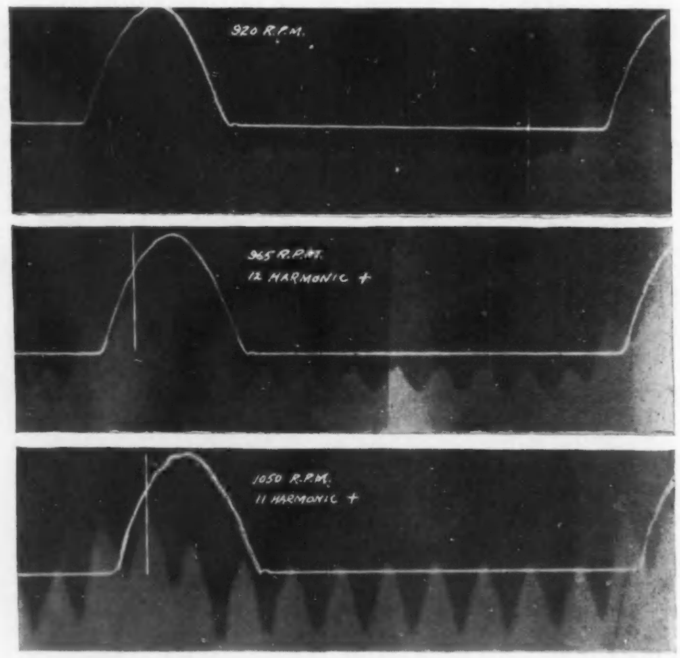
$$C = (K/\triangle) \times (d^3/DN) \times a_n \qquad (2)$$

in which C is the maximum amplitude of spring vibra-









Valve-Lift and Spring-Vibration Curves

The Valve Lift Is Shown by the Solid Line and the Spring Vibrations by the Jagged Shadow Effect. Except at 850 R.P.M., the Speeds Are Those of Maximum Vibration

Fig. 15—573, 603 and 640 R.P.M.

Fig. 16—675, 717 and 765 R.P.M.

Fig. 17—825, 850 and 885 R.P.M.

Fig. 18—920, 965 and 1050 R.P.M.

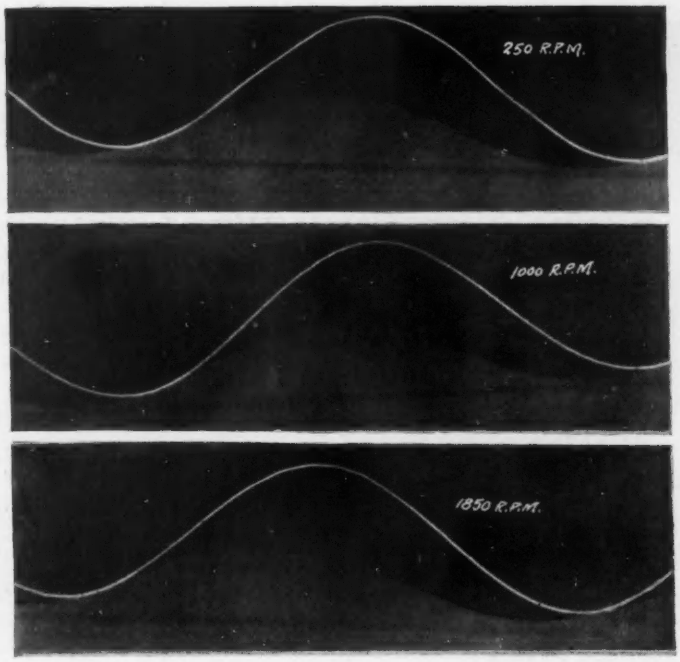


FIG. 19—VALVE AND SPRING DIAGRAMS MADE WITH HARMONIC CAM

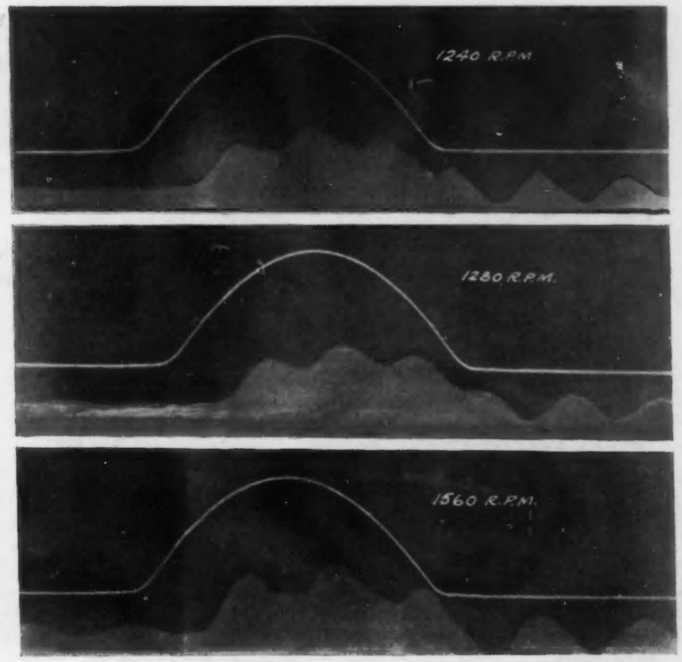


FIG. 20—RECORDS FROM A WELL-DESIGNED MECHANISM
The Change in Spring Frequency and the Almost Complete Damping of the Vibration during the Valve-Closed Period Are Due to a Variable-Pitch Spring

tion; K is a constant of proportionality, dependent also on the spring material; d is the diameter of the wire; D is the mean diameter of the coil; N is the number of active coils; a_n is the largest valve-lift harmonic that can come into resonance with the spring; and Δ is a damping factor.

The equation reveals the fact that valve-spring vibration depends on three main factors: the nature of the valve-lift curve, the dimensions of the spring, and the characteristics of the spring as to material and damping. These factors will be discussed separately.

Valve-Lift Curve.—The valve-lift curve influences the spring-vibration equation only by way of its harmonics. The harmonic to be considered is the largest one that comes into resonance with the spring within the speed limits of the camshaft. As the harmonics of lower order are in general of higher value, it follows that the design of the spring should be such that its frequency will be high enough to bring resonance with the dangerous harmonics beyond the maximum engine-speed. For example, an engine which has a maximum crankshaft speed of 3000 r.p.m., or camshaft speed of 1500 r.p.m., has its tenth harmonic in resonance at this speed with a spring whose frequency is 15,000 vibrations per minute. Of the camshafts we have studied, it has been found that harmonics up to the eleventh are dangerously high. In the foregoing example it would, therefore, be advisable to choose a spring with a frequency higher than 16,500 (11 x 1500).

As the harmonics are a function of cam contour, a possibility of controlling them by contour design suggests itself as a method of reducing spring vibration. The primary factors of cam-contour design are valve area and valve timing, but it is possible within the limits of these requirements to change the values of the harmonics. An example of this is given in Table 1. Cams No. 4 and No. 5 give the same valve-lift and timing, but it can be seen that nearly all of the harmonics of No. 5 above the tenth are of appreciably less magnitude than those of No. 4. Tests on these shafts showed that cam No. 5 was correspondingly better as regards valve-spring vibration.

Spring Dimensions.—The dimensions of the spring must be so selected that the value of C, in equation (2), is kept as small as possible without allowing the spring frequency to fall to such a value that it can come into resonance with the lower and more dangerous harmonics.

The cube of the wire diameter in the numerator of the above equation indicates that the wire size is the most important factor. The smallest wire-size consistent with stress, load and frequency requirements should be used, to minimize vibration. The number of coils and their diameter appear in the denominator and should therefore be made as large as possible.

Material and Damping.—Only steel wire is used for valve-springs; and, as neither the density nor the modulus of rigidity varies to any extent in the different kinds of steel used, factor K offers no possibility in the reduction of vibration.

Spring damping is to a certain extent the unknown factor in the above equation. Some investigators have suggested various devices for mechanically damping the spring by means of friction, but none of these has as yet become commercially practical. It is, however, certainly within the realms of possibility that a simple and effective method of spring damping may be developed for reducing vibration. A spring having a pitch which varies in such a way that several coils close as the valve lifts has been found to bring about considerable damping by interference.

Fig. 20 shows a valve-lift and spring-vibration record of a properly balanced valve-mechanism. The frequency of the spring, which is of variable pitch, is 15,600 vibra-

tions per minute in valve-closed position. The record indicates a considerable increase in frequency during valve lift and the resultant damping effect on the vibration. This is particularly evident in the lower record, which is that of the tenth harmonic. It can be seen at the left of the diagram that the spring vibrations have virtually died out before the valve begins its next lift.

Summary.—The rational steps in the selection of a combination of spring and cam to result in minimum vibration are:

(1) Harmonic analysis of the valve-lift curve
(2) Determination of the minimum frequency of the spring to keep it out of resonance with harmonics of high amplitude, up to the maximum engine-speed
(3) Selection of the spring with reference to equation (2) and to fit load requirements and stress and frequency limitations

APPENDIX

Harmonic Analysis.—A complete discussion of the subject of harmonic analysis is beyond the scope of this paper. For this the reader is referred to Engineering Mathematics, by C. P. Steinmetz[5], and an article on Wave Form Analysis, by P. M. Lincoln[6]. A modification of the Fischer-Hinnen method can be used to advantage in the analysis of the valve-lift curve. A simplification results if the analysis starts with zero

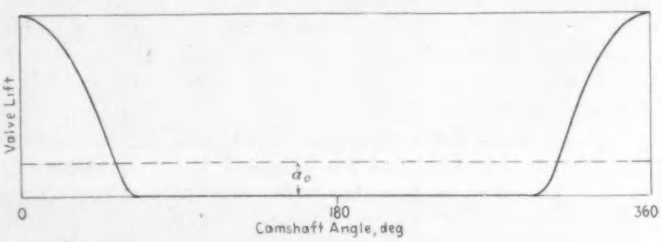


FIG. 21—VALVE-LIFT CURVE FOR HARMONIC ANALYSIS

degrees at the center of valve lift, as shown in Fig. 21. This brings the maximum value of all harmonics at zero degrees, and the equation can be written

$$y = a_o + a_1 \cos \theta + a_2 \cos 2\theta + \ldots + a_n \cos n\theta \qquad (3)$$

in which y is the valve lift, a_o is the valve lift averaged over 360 deg. of the camshaft, a_n is the maximum value of the nth harmonic, θ is the cam angle from the top of the valve lift, and n is the order number of the harmonic, a whole number.

The analysis of harmonics consists, first, of finding the value of a_0, which is the area under the valve-lift curve divided by the length of one cycle, or 360 deg., as shown in Fig. 21. This area can be found either by a planimeter or by plotting the curve on cross-section paper and counting the squares enclosed.

The coefficients a_1, a_2, ... a_n are then found. Starting with the highest, say $n = 30$, ordinates of the lift curve are measured $360/n$, or 12 deg. apart, beginning at θ = zero degrees. In this way a column of n ordinates is obtained, which is added together and divided by n, as shown in the sample calculation in Table 2. To obtain the maximum value of the nth harmonic, a_o must be subtracted from the above average. This gives a_n and all its multiples, as a_{30}, a_{60} and a_{90}; but in general these higher harmonics can be neglected on account of their small magnitude. When $n = 15$ is reached, however, a_{30} must be subtracted to obtain a_{15}. Likewise, to obtain a_{10}, it is necessary to subtract a_{20} and a_{30}. So, for any lower harmonic, all its multiples previously obtained must be deducted. Table 2 shows a sample analysis for five harmonics of cam No. 4 in Table 1.

Acceleration Harmonics.—The acceleration harmonics can be derived from equation (3), for valve-lift harmonics, by two differentiations

$$A = (d^2y)/(dt^2) = -\omega^2 n^2 \times (a_1 \cos \theta + a_2 \cos 2\theta + \ldots + a_n \cos n\theta) \qquad (4)$$

in which A is valve acceleration; ω is the angular velocity of the camshaft, in radians per second; and other symbols are the same as in previous equations.

For any harmonic, say the nth, the value of its acceleration equals $-(\omega n)^2 \times a_n \cos n\theta$, and the maximum value is

$$b_n = -(\omega n)^2 \times a_n \qquad (5)$$

in which b_n is the maximum acceleration. This is $-(\omega n)^2$ times the valve-lift harmonic.

It can be seen that, for any specific cam-and-spring mechanism, the frequency of the spring is proportional to ωn at resonant speeds, so that under these conditions the actuating force on the spring due to harmonics is proportional to the valve-lift harmonic. This can be expressed

$$b_n = KF^2 a_n \qquad (6)$$

in which F is the frequency of the spring.

Derivation of the General Equation of Spring-Vibration Amplitude.—The equation for the amplitude of forced vibration of a damped elastic system having one degree of freedom under the action of a periodic disturbing force[7] is

$$C = a / \sqrt{[(1 - T^2/T_1^2)^2 + (T^2Y^2/T_1^2)]} \qquad (7)$$

in which C is the amplitude of forced vibration, a is the deflection that would be produced by the maximum disturbing force if applied statically, T is the period of natural vibration of the system, T_1 is the period of the disturbing force, and Y is a quantity depending on the magnitude of the damping forces.

When the disturbing force is in resonance with the natural period of the system, $T = T_1$, and $C = a / Y$; but $a = P/R$, where P is the maximum value of the disturbing force and R is the rate of the spring; and $Y = \Delta / \sqrt{(MR)}$, where Δ is a damping constant and M is the active mass of the spring. Therefore, $C = P/\Delta \times \sqrt{(M/R)}$. Since, according to Ricardo[8], $F = K_1 \sqrt{(R/M)}$, then

$$C = K_1 P / (\triangle \times F) \qquad (8)$$

The disturbing force P, however, depends on the value of the acceleration harmonic of the valve motion which is in resonance at any given camshaft speed and also on certain spring characteristics. In other words, a given acceleration harmonic at a certain camshaft speed produces different disturbing forces on springs of different dimensions even though they have the same frequency. P being the disturbing force; m, a mass factor dependent on the linear-unit weight of the spring wire and the mean diameter of spring coil; b_n, the maximum value of the acceleration harmonic in reso-

[5] McGraw-Hill Publishing Co., 1917.

[6] See *Electrical Journal*, July, 1908, p. 386.

[7] See Applied Elasticity, by S. Timoshenko and J. M. Lessells, p. 830; Westinghouse Technical Night School Press, 1925.

[8] See The Internal Combustion Engine, by H. R. Ricardo, vol. 2, p. 210; D. Van Nostrand Co., 1923.

TABLE 2—SAMPLE ANALYSIS OF HARMONICS

18th Harmonic		17th Harmonic		16th Harmonic		15th Harmonic		14th Harmonic	
Cam Angle, Deg.	Lift, In.	Cam Angle, Deg.	Lift, In.	Cam Angle, Deg.	Lift, In.	Cam Angle, Deg.	Lift, In.	Cam Angle, Deg.	Lift, In.
0	0.438	0	0.438	0	0.438	0	0.438	0	0.438
20	0.362	21.2	0.353	22.5	0.342	24	0.329	25.7	0.312
40	0.145	42.3	0.113	45.0	0.074	48	0.038	51.4	0.012
60	0	63.6	0	67.5	0	72	0	77.2	0
80	0	84.8	0	90.0	0	96	0	102.9	0
100	0	106.0	0	115.5	0	120	0	128.6	0
120	0	127.2	0	135.0	0	144	0	154.3	0
140	0	148.5	0	157.5	0	168	0	180.0	0
160	0	169.7	0	180.0	0	192	0	205.7	0
180	0	190.9	0	205.5	0	216	0	231.4	0
200	0	211.8	0	225.0	0	240	0	257.0	0
220	0	233.0	0	247.5	0	264	0	283.0	0
240	0	254.2	0	270.0	0	288	0	308.5	0.012
260	0	275.4	0	295.5	0	312	0.038	334.3	0.312
280	0	296.3	0	315.0	0.074	336	0.329	Total	1.086
300	0	317.3	0.113	337.5	0.342	Total	1.172	Average	0.0776
320	0.145	339.0	0.353	Total	1.270	Average	0.0782	Subtracting a_o	−0.0796
340	0.362	Total	1.370	Average	0.0794	Subtracting a_o	−0.0796	$a_{14} + a_{28} =$	−0.0020
Total	1.452	Average	0.0805	Subtracting a_o	−0.0796	$a_{15} + a_{30} =$	−0.0014	Subtracting a_{28}	+0.0001
Average	0.0807	Subtracting a_o	−0.0796			Subtracting a_{30}	−0.0001		
Subtracting a_o	−0.0796								
$a_{18} =$	+0.0011	$a_{17} =$	+0.0009	$a_{16} =$	−0.0002	$a_{15} =$	−0.0015	$a_{14} =$	−0.0019

nance; d, the wire diameter, in inches; and D, the mean diameter of the coil, in inches, this disturbing force can be expressed: $P = mb_n$, also $m = K_2 d^2 D$, and therefore $P = K_2 d^2 \times D \times b_n$. Substituting for P in equation (8),

$$C = K_3\,(d^2 \times D \times b_n)/(\triangle \times F)$$

A further simplification results if we substitute for b_n the value given in equation (6), as follows:

$$C = K_4\,(d^2 \times D \times F \times a_n)/\triangle$$

Substituting equation (1) for F, we have

$$C = K_5(d^2 a_n)\;/\;(D \times N \times \triangle)$$

which is equation (2) in the text of this paper.

International Cartels

As a general rule, all international cartel organizations are attempted in such shambles of competitive warfare and mutual wariness that efforts at union meet with perfectly understandable initial difficulties. Cartels that do not consist of associations of different nationalities but are based upon agreements between comparatively few undertakings, in new branches of industry, and upon the utilization of specific patents under license, are more easily formed and apparently last longer.

A number of international cartels have been formed on a monopoly-right basis in the chemical, electro-technical, metal, petroleum, and other industries. But these, too, do not face the larger problem of successful operation which the steel and other cartels face.

What Europe has most sorely needed is a technique for economic union, across political boundaries, in broad industries, and it is obviously that technique which is now being forged out, with much heat and flying sparks. The quota method is most readily agreed upon, for that is after all statistically calculable from the present relative positions of the industries; but agreements upon the more subtle factors involved, unit world-sales organization and price levels, come less easily. Both of these factors have to do with the market, which is not technically under absolute control, like production ratios.

It is acknowledged by experts who have studied the subject that the limitation, and if possible complete removal, of international competition, rather than merely the command of production, is the strategic key to operating success for international cartels. The questions of supply and price become exceedingly important in an international cartel, while the seriousness of the sales factor is naturally minimized as the command over competition increases. Agreements of the quota-imposing type of international cartels intervene directly in the regulation of supply, establishing the level of output for each member, on a calculated basis of minimum demand, and allotting corresponding supplies, centrally purchased.

The critical point of penalties for exceeding quota is that provision for fluctuation is provided, if the set penalty is paid; not because loyalty to the cartel is demanded, but because a mathematical calculation is put to work so that reduced cost of production may be made an object and a possibility of profit; since increased output, if attempted, may bring a lower cost advantage, which even after paying the penalty leaves a profit. The penalty nevertheless acts as a stabilizer to the industry as a whole.

In any case of quota setting for any organization, change of quota must be arranged for as contingencies arise. The international cartel recognizes the instant right of a cartel member to have its quota raised if its own national demand increases. Thus the cartel member is not handicapped by international membership when its own local efforts boom trade. It gives elbow room to enterprise. Countries producing cartellized articles of unfinished types of industrial goods usually have highly developed finishing industries also, and low costs of production. The plan thus hinders the creation of "mushroom" finishing industries in countries where the cartellized goods are imported. — J. George Frederick, in *Trade Winds*.

Airplane Lighting Requirements

By L. E. Lighton[1] and W. M. Johnson[2]

Los Angeles Aeronautic Meeting Paper

INCREASE in the amount of night flying with the advent of airplanes into the commercial field makes more acute the need for proper lighting facilities, not only of airports and airways, but of the airplanes themselves. As only about one-half of the regularly used airways in this Country are lighted for night flying, and few airports are equipped with lighting facilities for night landings, it is necessary for airplanes to be provided with lighting equipment for flying and for emergency landing at night.

Besides the high-intensity lighting needed for following unlighted airways and for landing, airplanes need navigation lights and illumination for the instruments and the cabin.

Immediate study and direction should be given to the problems of meeting each of these requirements most effectively and economically before it becomes too difficult to standardize methods and equipment.

The authors divide the entire problem into (*a*) lighting requirements, (*b*) lighting equipment, and (*c*) energy supply and distribution; and each of these divisions of the subject is discussed.

Landing-lights are said to present the most difficult problem, because of the high intensity and large quantity of light required, and the stringent weight and space limitations imposed on the equipment. When tests have been made to determine what quantity and distribution of light are required, numerous other problems will face the equipment designer. Some of these are location of the units; reduction of wind resistance, vibration, weight and energy losses; accessibility; and protection against the elements.

With either a battery or a battery-generator system of energy supply, regulation of the voltage at the lamp socket to reduce to the minimum the voltage variation is important. From 40 to 50 per cent of commercial airplanes used in night flying are generator-equipped, as standard battery-equipment does not furnish sufficient current for continued use of one landing-light in bad weather for following natural landmarks between beacons. Standardization of batteries and lamps to provide a longer period of illumination for emergency landing in bad weather should not be difficult, according to the authors.

The designing of airplane landing-lamps in particular will be a greater problem than the designing of automobile lamps unless some standard of installation, wiring and operation can be worked out at the present stage of the industry. Therefore, investigation should be started at once to lead to standardization of the lighting equipment, its location, and the wiring. Recommended practice should also be established for the battery and generator systems and the sizes to be used for night flying.

The discussion emphasizes the need of ascertaining the lighting requirements of airplanes used in commercial service and of standardizing the units promptly so that manufacturers shall know what they will be expected to produce.

WITH the advent of airplanes into the commercial field, night flying is becoming more and more common. As the number of night-flying hours increases, the necessity for proper lighting facilities becomes more acute. This applies not only to the lighting of airports and airways but also to the lighting of the airplanes themselves, since these respective facilities are somewhat dependent upon each other.

From figures published by the Department of Commerce, it has been estimated that only about one-half of our regularly used airways are lighted for night flying, and a very small percentage of our airports are equipped with lighting facilities for night landings. This indicates a necessity for airplanes being provided with lighting equipment for scheduled night flying as well as for emergency landings.

In addition to the high-intensity lighting needed for following unlighted routes and for landing in unlighted fields, night-flying airplanes also require navigation lights and illumination of the instruments and the cabin. To fulfil each of these lighting requirements most effectively and economically, some immediate study and direction should be given to each phase of the problem before diversity of opinion and habit set precedents which may become difficult to standardize.

The entire problem of airplane lighting resolves itself into three logical divisions:

(1) Illumination requirements
(2) Lighting equipment
(3) Energy supply and distribution

(1) *Illumination Requirements*.—The Department of Commerce has already specified certain requirements to be met; for example, navigation lights must be visible at a certain distance and through certain angles. While the Department also requires electric landing-lights on commercial passenger-planes when flying at night, no specifications as to illumination are given. Neither, to the writers' knowledge, are instrument lights or cabin lights required, although these already are being installed on many airplanes.

The problem of illuminating the cabin properly is analogous to motorcoach lighting and will perhaps in practice resolve itself to a minimum requirement of a specified number of watts per seated passenger. Instrument lighting, however, presents a somewhat different problem from that encountered in automotive service; most pilots want only just enough light on the instruments to enable them to be read, so as to minimize interference with vision outside the airplane.

Landing-lights present the most difficult lighting prob-

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[2] M.S.A.E.—Principal automotive lighting specialist, engineering department, National Lamp Works of the General Electric Co., Nela Park, Cleveland.

lem. The greater speeds and hazards make necessary very much higher orders of intensity and quantity of light than those required even under extreme conditions of automotive service. Yet the limitations on electrical equipment, as regards both weight and space, are more stringent than in any other service.

The opinions of pilots vary as to the quantity and distribution of light which should be supplied for landing purposes. Some pilots desire a concentrated beam alone, while others would have this supplemented by a wider beam-spread for close-range service. However, there seems to be considerable unanimity of opinion that the long-range concentrated beam is desirable for following railroads, highways, and natural landmarks along unlighted routes on dark nights. Therefore at least one unit should be provided for this purpose, preferably one which can be directed at will by the pilot.

For landing and searchlight service the quantity of light, that is, the size of lamp and the energy required, depends to a considerable extent upon the distribution of light from the unit. As yet no tests have been made to determine what distribution of light is required, and, until actual data are available, no definite decision can be made on the proper lamp for this service.

Problems Facing the Equipment Designer

(2) *Lighting Equipment.*—After investigations have shown the quantity and the distribution of light required, the equipment designer will be faced with many problems. First, there will be the problem of location of the units so as to give best visibility for the pilot, least wind resistance, the minimum vibration of the unit, and the minimum energy losses and weight in the electrical system; second, there will be the mechanical construction of the units themselves with respect to minimum weight, to accessibility, and to adequate protection from the elements.

Maximum visibility for the pilot is obtained, in general, by locating the units as far from the line of vision as is practicable, and by preventing the light from striking polished surfaces of the airplane, especially the propeller. The location and size of the units are important factors; tests have shown that two landing-lights located on the wing tips may decrease the speed of the plane as much as 6 or 7 m.p.h. Lighting equipment that can be inserted completely within the wing or folded within the wing when not in use will be of great value. This problem is easy of solution on the thick-wing monoplane, but is hard to solve on the thinner wing of the biplane. While the unit itself can be designed to withstand the vibration encountered, the service life of the lamp is greatly shortened by excessive vibration.

Demands Made on Energy Supply

(3) *Energy Supply and Distribution.*—The present trend seems to be toward a 12-volt system, and from the lighting standpoint this is perhaps the best compromise. Generally speaking, a 6-volt lamp will more readily withstand the vibration inherent in airplane service, but this advantage is offset somewhat by the lower energy losses (resulting from the lower current) in the 12-volt system. In the final analysis, the regulation of voltage at the lamp socket is of greater importance than the particular voltage used. It should be remembered that the light emitted by an incandescent lamp varies as the 3.5 power of the voltage. With a battery system only, there is a considerable variation in voltage as loads of various wattages are switched on. Likewise, in a battery-generator system, voltage variations are introduced whenever the generator cuts in and cuts out of the circuit, and it is desirable to design the layout of the electrical equipment so that these variations will be reduced to a minimum at the socket.

There seems to be no set standard on the use of generator equipment in connection with the storage battery for lighting the airplane. A rough estimate indicates that about 40 to 50 per cent of the airplanes used in commercial night-flying are generator-equipped. Without the generator, the present standard battery-equipment (a 65-amp-hr. battery S.A.E. No. 36) will, when fully charged, provide fair illumination for landing for a maximum of about 33 min. under good-design conditions and for 5 to 10 min. less than that when the design or installation conditions are not of the best. Some pilots have found the use of one landing-light valuable in bad weather as a means for following natural landmarks between intermediate beacons; here a generator becomes a necessity, to relieve the battery of this extra demand for energy. The use of a generator as a vital part of the electrical equipment is therefore certain to increase.

While no definite data are available covering landing-light voltages at the sockets on generator-equipped airplanes, investigations made on airplanes equipped with a battery alone have shown that the lamps available at present give from 40 to not more than 60 per cent of their rated illumination when used with the battery fully charged. The latter figure is the best possible condition that has been observed to date on an installation without a generator. One-third rated illumination is considered the absolute minimum with which a safe emergency-landing can be made, and this minimum will be reached in slightly less than 26 min. under conditions observed on some of the airplanes investigated. This is plenty of time if a fully charged battery is available at the time of emergency, but the emergency is very likely to arise in bad weather after considerable battery capacity has already been used. The standardization of improved design to provide illumination for a longer time with present electrical power-equipment should not prove a difficult task.

Pilots Want Greater Battery Capacity

On account of the present inefficiencies of equipment, many pilots have asked for greater capacity in storage batteries than is provided by the largest batteries now recognized by S.A.E. standards. Larger batteries can be provided, but only at an increase in weight that seriously affects the carrying capacity of the airplane. Perhaps the effect of a larger battery can be obtained by improving the efficiency of the present lighting equipment. Voltage losses as high as 2.2 volts in a single circuit have been observed, indicating that more attention should be given to proper wiring.

Although the addition of a generator will provide better voltage and lighting conditions with present equipment, it must be considered that the powerplant, and consequently the generator, seldom will be operating under conditions of an emergency landing. It therefore follows that these landing-lamps should be designed to operate efficiently on battery supply only, and that a means should be provided for their protection from the higher voltage when the generator is operating.

The design of lamps for automobile use has required a great amount of investigation to secure the most efficient and satisfactory operation. It appears that the design of lamps, particularly the landing-lamps, for airplanes will be an even greater problem unless some standard of installation, wiring, and operation can be worked out at the present stage of the industry. It therefore seems advisable to start investigations immediately that will lead to a standardization of airplane lighting-equipment, of the location of this equipment, and of the wiring. At the same time, recommended practice should be established for battery and generator systems and for the sizes of these to be used in night-flying service.

THE DISCUSSION

CHAIRMAN EDWARD P. WARNER[3]:—There is no committee in the Society bearing directly on aeronautical research and this is a clear case in which, as a result of research and collective experience, a standard will ultimately be needed. It therefore seems appropriate, lacking any other proper outlet, for the Aeronautical Standards Division to consider the general question of airplane lighting, the range of sizes which should ultimately be covered, the probable approximate number of sizes, and the points at which they should be spaced through that range, as pertaining to aircraft standardization, even though the time is by no means ripe for standardization, because of the lack of adequate data and experience on the effect of changing the amount and type of lighting.

A. J. UNDERWOOD[4]:—This subject came about at the request of three manufacturers who have been involved in the problem of trying to meet the requirements that have been set up by various airplane manufacturers for some sort of lighting. Almost simultaneously letters came to us from D. S. Cole, of the Leece-Neville Co.; Mr. Johnson, of the General Electric Co.; and Mr. Lighton, of the Electric Storage Battery Co., for assistance from some meeting of airplane and airplane-lighting-equipment manufacturers in determining what they could do to furnish equipment to meet present requirements. They asked us to do something immediately, as they were being harassed considerably for some equipment at once that would give adequate landing-lights. We are endeavoring to elicit some information and ideas from others as to what illumination is required for proper lighting at present, and how this requirement can be met, what generator capacities are needed, what kind of lamps are desired and how they can be placed so that they will not create too much head-resistance. Mr. Lighton and Mr. Johnson have written this short paper on the existing conditions in the hope that others will give further enlightenment. If anyone has any thoughts that will be of help to a committee or to any group that may meet to consider this problem, we wish he would let us have his ideas so that some guidance may be provided, because I believe that this is going to be a very vital subject which will be given almost immediate attention.

A. J. POOLE[5]:—My company is earnestly trying to find out just what the requirements are for lighting purposes in aviation work. I am frank to admit that we are groping in the dark now; everybody seems to have a different idea as to what the lighting should be, whether it should be of 6, 12, 24 and 32 voltage and, furthermore, just what the capacity of the generator should be.

Some mention was made of the lighting load for a closed airplane being similar to that of a motorcoach. The coach lighting-load has been going up by leaps and bounds; it is almost to the point now where an individual lighting plant is required. Two or three years ago a generator of 5-in. diameter, with 150, 200 or 250-watt output, was ample. Now generators 8 in. in diameter and giving an 800 and 1000-watt output are used. We should like to know what is being required of the lighting system for aviation work. I think that expresses the desire of most of the generator manufacturers.

CHAIRMAN WARNER:—I think that is practically what Mr. Lighton and Mr. Johnson would like to know. They want to elicit discussion that will lead to comparisons of experience and to further tests.

Speaking as a passenger, for I have had very little connection with the actual design or operation of aircraft lighting at any time, it seems to me that the lights now used on the air-mail planes operating at night are admirable in their adequacy. The fact that the landing-lights are sufficient for night operation is evidenced by the quality of their operation. The lights in the cabin of the machine in which I flew through one night on my way out to Los Angeles were ample to read by without eye strain, which is more than I can say for a great many of the motorcoaches I have ridden in even in recent months.

There seems to be sufficient engine-driven-generator capacity to take care both of the larger-size landing-lights and the cabin lights, although, to be sure, that was a small cabin.

TWENTY-FIVE-WATT GENERATOR AMPLE

C. L. EGTVEDT[6]:—We use a 25-watt generator, and at present are using the same size on the 12-passenger airplanes. It seems to be ample. We have a water heater on the same system but current for that is used mostly during the daytime and can be shut off at night. We use one battery. I am not certain which battery size is used for the three-engine plane. First we installed two but found this unnecessary. The reason for two was that it was thought that more power would be needed for starting the engine during cold-weather operation; however, we found we could obviate the necessity of carrying additional batteries by first starting the engine that has the generator attached.

CHAIRMAN WARNER:—What lamp wattage do you find necessary for the type of cabin lighting you are using in the two-passenger machine, or in the distribution for the new air-transport?

[3] M.S.A.E.—Assistant Secretary of the Navy for Aeronautics, Navy Department, City of Washington.

[4] M.S.A.E.—Standards Department, Society of Automotive Engineers, New York City.

[5] M.S.A.E.—Manager, manufacturers' sales department, Robert Bosch Magneto Co., Long Island City, N. Y.

[6] General manager, Boeing Airplane Co., Seattle.

MR. EGTVEDT:—We really have no opinion, because we have not operated the new transport at night yet. We have had the lights turned on at night with the plane on the ground, and there seems to be ample light for reading. We always find that the landing-light requirement on the present planes is greater than the requirement for the lighting for reading and the like; and the pilots will turn off the major portion of the current used for the cabin lights when they are required to land. It is planned to leave a light in the forward end of the cabin so that passengers can see the instruments, which are mounted forward.

CHAIRMAN WARNER:—It is reasonable to expect that the foot-candles required for reading or for the convenience of the passengers in an airplane would be less than in a motorcoach because there is less vibration and the light need not be as powerful for examining small print or any other fine work with the same accuracy.

LIGHT FOR VISIBILITY IN FOG

SAM L. BOUKARD[7]:—We have been doing some development work along the lines of navigating and landing-lights and have talked with several of the operators of commercial lines, as well as with men in the Army Service. We have been working along the lines of a lamp having a small head-resistance area to be mounted below the line of vision of the operator so that in foggy or rainy conditions the pilot does not have to look through any portion of the projected beam, but rather over it. We have found, in automobile practice, that this gives far better visibility under foggy conditions, and I imagine that under certain conditions such landing-lights for forced landings would be of most value.

I should like to ask if any member can give me data on the size of incandescent lamps used in the present lights, and the ampere absorption?

CAPTAIN MOSES[8]:—I have seen Mr. Wood's demonstration on an automobile of the lamp Mr. Boukard described, and I think it is well worth looking into by those who are interested, not only in airport lighting but also for the airplane.

WORKING ON SMALL RETRACTABLE LAMPS

MR. EGTVEDT:—Another requirement is coming up which we are studying in connection with the lighting requirements. This is the use of generators for radio equipment. This service indicates the need of a separate unit for the entire system, which can be operated when the airplane is on the ground. Such a unit has been designed and will be in operation very shortly for a trial.

Frankly, I do not know the sizes of the landing-lights because they have been standard equipment developed by the military service, and at the time we started operation on the air-mail route we continued with the equipment which had been installed up to that time, merely changing it to some extent to meet our requirements. However, the thought of decreasing the size of the landing-lights has greatly interested us lately because we have been designing, as others have, retractable lights. On account of the extreme resistance of the present lamps, which are exposed in the air flow, their installation on the plane is very important. The landing-lights on the single-engined airplanes operated on the mail routes point out considerably to prevent the light shining into the propeller and being reflected. They are made so that they can be turned to direct the light downward to detect railroads and other landmarks better. Others are retractable and can also be directed.

J. A. KINDELBERGER[9]:—The answers to almost all of the questions that have been asked are to be found in the Army Handbook for Airplane Designs, published and obtainable in Dayton, Ohio. The Army has been experimenting for 10 years on this problem and has standardized on generators and landing-lights. In fact, the present successful landing-lights of the Air-Mail Service are of the Army type, and in the Army Handbook is a table of ampere consumption per minute of landing-lights, various radio sets, instrument lights, and so on, from which a total can be taken and the generator requirement very easily figured.

CHAIRMAN WARNER:—I think it is the thought of those who are anxious to cover the field completely in manufacturing equipment that there is likely to be a need for lamps of somewhat lower power than those used by airplanes regularly flying at night on a fixed schedule. In the Army, the lighting was designed to meet all possible requirements under very bad conditions, and this has been adopted by the air-mail operators for bad conditions.

SHIELDED LIGHTS AND VOLTAGE REGULATION

A. H. BABCOCK[10]:—Some years ago I made some experiments with a shield over a headlight lamp on a locomotive to see if we could prevent the glare caused by reflection of the stray light from the headlight by snow and fog. The bulbs we used were almost spherical; therefore I put a reflecting material on the upper forward quadrant. The first experiment was made with filter paper moistened and spread over the bulb so that it conformed closely to the surface. When it dried, all of the paper below the horizontal plane and back of the vertical plane was cut off, so that the upper forward quarter of the lamp was covered with this reflecting surface. As this surface was virtually spherical, the light reflected from it passed through the filament center to the reflector, whence it issued again as though it came originally from that center, and was thus put to practical use. All the engine men who tried that reported very favorably. They said they never before had been able to see anything when running in the fog and snow.

Afterward I made a number of these from thin metal and put them on automobile head-lamps. Subsequently I took out a patent on the idea. The effect of the device is really startling; if you keep that stray light out of your eyes, you can see the road directly through the beam of light from the head-lamp and can drive without any hesitation. I do not know why the thing failed to catch on, unless it was that the manufacturers of automobile headlights had other things to think about.

With reference to one other point raised, it is very likely that the gentleman with the General Electric Co. who contributed this paper knows all about a generator that the company built for a while for the Electric Storage Battery Co. under the Rosenberg patent. The generator is of peculiar construction, in fact, it is almost

[7] A.S.A.E.—American Woodlite Corp., San Francisco.

[8] Western Air Express, Berkeley, Cal.

[9] Douglas Co., Santa Monica, Cal.

[10] Consulting electrical engineer, Southern Pacific Co., San Francisco.

the reverse of the ordinary generating practice; but the fact is that, on an automobile that I ran for a number of years, the voltage curve with that generator, at any speed from 500 up to 1900 r.p.m. was flat. The result was that, when the storage battery used on that car was taken back to the manufacturer seven years after it was put in operation, and was taken apart and the experts were asked to estimate the length of time it had been in service, the longest estimate was 14 months. That was the effect on that battery of constant-potential charging.

Regarding a point raised by Mr. Lighton in the paper, it is better to design lamps for close regulation. If a generator of that type could be used—and I say that because its weight efficiency is very poor, a 50-watt generator weighing nearly 50 lb.—we could have a generator of exceedingly close regulation at any speed whatever. The voltage curve rises to a certain point and then flattens right out. That would make it possible, it seems to me, to couple the generator up to something where speed regulation was not important and get fine lamp regulation.

CHAIRMAN WARNER:—That is an interesting contribution. The suggestion that the automobile headlight manufacturers have had other things to think about, as a reason for not taking up any particular line of development, certainly seems possible to those who have been active in the Society research work during the last few years.

Airport and Airway Lighting

THE lighting required at an airport, under the rating regulations of the Department of Commerce, consists of an airport beacon to locate and identify the airport at long range; a boundary lighting system, to outline the landing areas; red obstruction lights; green range lights on the safe approaches; a lighted wind-indicator, to show the direction and velocity of the wind; floodlighted hangars and buildings, for perspective marking; a floodlight system illuminating the landing area to the proper brilliancy without glare; a ceiling light and height indicator.

Safe landing under conditions of fog is not yet an assured accomplishment. Fog-penetrating lights have often been mentioned but are not yet available.

The use of red course-lights at airway beacons where there is no lighted landing-field, and yellow course-lights at intermediate landing-fields, has already been initiated. The use of a flashing green code-light as an auxiliary airport-beacon completes a rational system of indicating available landing places by colored lights. The code characteristic serves to identify the airport. It is also suggested that boundary cone-markers 3 ft. in diameter, 3 ft. high, painted alternate bands of chrome yellow and white, separated by a narrow black band, be used in connection with the boundary-lighting system and floodlighted to show perspective.

The establishment of an airway lighting system for clear-weather visibility is comparatively simple. Under such conditions the patterns of city lights and stray lights are beacons of the first magnitude but under adverse weather conditions the stray lights lose their characteristics and become confusing, competitive lights. The airway lighting system should be designed for poor-visibility flying. The beacon light should have an optical design that utilizes the greatest percentage of flux from the light source, concentrating the light into a high-intensity beam of candlepower in excess of competitive or stray light, and that projects the beam into the sectors most useful to the pilot. The light should have a distinctive characteristic so as to be recognized instantly among the stray lights as a light of aeronautical character, and should have individuality so as to be recognized as a landmark of known geographical location. The duration of flashes should be sufficiently great to develop the maximum luminous value on the retina of the eye, and the luminous period and frequency of flashes should be proper to fix the location on the horizon. The lights should be spaced as close as availability of funds permits.

Red course-lights are used at beacons on intermediate landing-fields. The lights are elevated to show the greatest candlepower to the pilot when he is flying above the adjacent beacon at a height of 500 to 1500 feet. The fields are marked with yellow course-lights, and the landing area is outlined by boundary cones and lights spaced approximately 300 feet apart.

PRIVATE AERONAUTICAL LIGHTS

Privately established aeronautical lights are certified as to their adequacy by the Department of Commerce under the Air Commerce Act. The airways lights established by the Department, and the majority of airport lights, are revolving beacons. This type of light has been developed and characterized as aeronautical lights. Lights established on an airway are given characteristics similar to airway lights, revolving 6 times per min. and elevated about 1 deg. above the horizon. Rotating beacons that are not located on an airway revolve 2 times per min. and are elevated 15 deg. or more. Private advertising lights that serve a useful aeronautical purpose must mark a landing-field or establish a landmark from which a departure can be taken to reach a landing-field. A fixed projector showing a high-intensity luminous pencil of light is directed toward the airport.

Unfortunately, great demands are made for the establishment of revolving beacons for purely advertising purposes that do not serve the best interests of the pilot. Most of these lights are not certified or authorized. The establishment of a great number of advertising lights of aeronautical character leads to confusion and destroys the value of true aids. Before authorizing and certifying private aeronautical lights, the local aeronautic interests and air transportation companies are requested to submit their reports and recommendations as to the purpose served by establishment of such lights. Proper attention to these matters will prevent the establishment and certification of improper lights. The Air Commerce Act authorizes the discontinuance of any false light or signal at such place or operated in such manner that it is likely to be mistaken for a true light.—From address by F. C. Hingsburg at the International Civil Aeronatics Conference, City of Washington, December, 1928.

Fluidity and Other Properties of Aviation-Engine Oils

By E. R. Lederer[1] and F. R. Staley[2]

Annual Meeting Paper — *Illustrated with* Charts and Diagrams

SELECTION of the proper crude is an important consideration in the manufacture of aviation-engine oils. The authors class petroleum into asphalt-base, paraffin-base and mixed-base crudes, stating that scientific research and actual-performance tests have demonstrated the advantages of paraffin-base oils over asphalt-base oils for aviation engines, and that their superiority is now conceded by most authorities. Much attention has been given recently to the dewaxing and fractionating of lubricating oils, and this has resulted in an improvement in their quality and in their unrestricted use as "all-weather aero oils."

After quoting statements from several authorities who agree that an oil which will meet both summer and winter requirements is desirable, the authors give the definitions of viscosity, fluidity, consistency and plasticity determined by the American Society for Testing Materials and then discuss the fluidity or consistency of aviation-engine oils below their A. S. T. M. pour-points and the significance of dewaxing paraffin-bearing oils.

Charts are presented and explained which show the effect produced on the A. S. T. M. pour-point by the addition of wax to a partly dewaxed paraffin-base oil, and the behavior of an oil at three different temperatures. A diagram of a fluidity machine is given and the results of tests made thereon are shown. Curves showing the comparative fluidities of three kinds of Grade 1 aero oils and an oil produced from a California crude; a similar series of curves for Pennsylvania and Ranger paraffin-base and for Coastal oils having viscosities corresponding to Grades 2 and 3 aero oil; and a series of fluidity curves for several oils from various crudes corresponding to Grade 4 Liberty aero oil are presented.

In conclusion, oil consumption is discussed and the subject of the stability of an oil in service is treated. Other methods of testing are outlined, and the statement is made that the necessity for dewaxing paraffin-base oils and fractionating them to obtain a close-cut homogeneous product has resulted in the development and installation of new types of equipment for both the steam and vacuum distillation of lubricating oils. The authors say that these developments are of great importance for the development of all high-speed, high-compression, internal-combustion engines.

THE phenomenal growth of the aviation industry is demanding a larger supply of lubricating oils of higher grade each year. The manufacture of an oil that best meets the requirements for an airplane type of powerplant presents many problems to the petroleum chemist and technologist. Oil consumption and stability are important considerations because of the severe service which the oil must undergo. Furthermore, the long distances traversed and the great altitudes encountered within a comparatively short time often necessitate starting and operating under widely different temperature and pressure conditions.

Selection of the proper crude is an important consideration in the manufacture of aviation-engine oils. The three general classes of petroleum are known as asphalt-base, paraffin-base and mixed-base crudes. The physical and chemical properties of the third class approach either those of the paraffin or of the asphalt base, depending upon the relative content of these two substances present in the crude petroleum. Scientific research and actual-performance tests during the last two years have demonstrated the advantages of paraffin-base oils over asphalt-base oils for aviation engines, and their superiority is now conceded by most authorities.

Until recently the pour-point of the average commercial paraffin-base oil of suitable viscosity for aviation use was too high because of the wax content; but, during the last year, much attention has been given to the dewaxing and the fractionating of lubricating oils by the refineries in this Country, and this has resulted in an improvement in their quality and in their unrestricted use as "all-weather aero oils."

Oils for Summer and Winter Use

In his article on Lubricants for Aircraft Engines[3], Commander E. E. Wilson, U. S. N., former head of the engine section, Bureau of Aeronautics, Navy Department, states that the Navy needs an oil which will meet both summer and winter requirements. The Bureau of Aeronautics invited the manufacturers of the petroleum industry to coordinate their efforts with those of the Navy Department. To quote Commander Wilson:

> The Navy purchases two grades of aviation lubricating-oil, known as "summer" and "winter" grades. The matter of starting a cold engine is one of the controlling factors of choosing lubricating oils for aircraft engines. If an oil could be found with a very low pour-point and a viscosity of over 90 sec. at 210 deg. fahr., we could reduce the varieties of oil required from two to one and use the same oil the year round. This desirable solution is of more than ordinary interest to the Navy.
>
> The Bureau of Standards approached the problem in a scientific way by plotting the logarithm of viscosity against the logarithm of temperature and establishing a coefficient of viscosity by determining

[1] M.S.A.E.—Vice-president and director, Texas Pacific Coal & Oil Co., Fort Worth, Tex.

[2] Chief chemist, Texas Pacific Coal & Oil Co., Fort Worth, Tex.

[3] See *Oil and Gas Journal*, Nov. 5, 1925, p. 158.

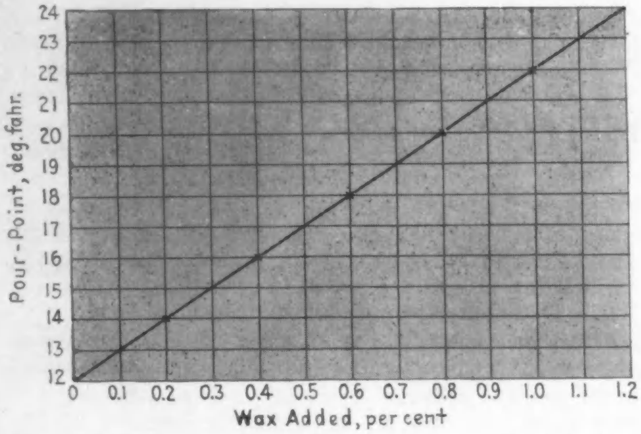


FIG. 1—EFFECT OF ADDED WAX ON THE A.S.T.M. POUR-POINT

the ratio of the logarithm of viscosity at 100 deg. fahr. to the logarithm of viscosity at 130 deg. fahr. The results of this plot are shown in the chart attached, from which it will be seen that, for both light and heavy oils, the naphthene-base oils show a much steeper curve than do the paraffin-base oils. In other words, paraffin-base oils seem more suitable for our purposes.

In their paper on Motor-Oil Characteristics and Performance at Low Temperatures[4], Wilkin, Oak and Barnard showed the advantages of wax-bearing oils over asphaltic oils on account of their relatively small temperature-viscosity coefficient. Quoting from the paper, their work shows

> definitely the necessity for both low temperature-coefficient of viscosity and low pour-test in lubricants to be used at low temperatures. . . . An oil with both characteristics is the ideal for low-temperature operation.

At present, our knowledge of the laws of plastic flow is limited and much research work remains to be done along these lines. Many different types of apparatus to test the fluidity or consistency of lubricating oils have been developed for studying the behavior of lubricating oils below their pour-points, but no specific apparatus has as yet been standardized by the petroleum industry. Below its pour-point, an oil is not a true viscous liquid; hence the extension of the viscosity-temperature curve below the pour temperature does not picture its behavior.

OIL CHARACTERISTICS DEFINED

As defined by the American Society for Testing Materials:

> *Viscosity* if a liquid is the measure of its resistance to flow. It is measured in terms of a unit of force designated as "poise." The fundamental characteristic of a true viscous liquid is that its rate of flow through a capillary is directly proportional to the pressure applied.
>
> *Fluidity* can be defined as the reciprocal of absolute viscosity in poises (Herschel); . . . or, in a broader sense, fluidity merely refers to the mobility of the oil in the engine without considering the force-flow ratio.
>
> *Consistency* is that property of a material by which it resists permanent change of shape and is defined by the complete force-flow relation. In non-turbulent flow, if this relation is linear, the material is said to be fluid; otherwise, it is plastic.
>
> *Plasticity* is that property of a material by which, as the shearing stress is lowered, it resists permanent change of shape relatively more than in the case of a fluid; hence, for a plastic material, the ratio of flow to force is not constant.

The fluidity or consistency of aviation-engine oils below their A.S.T.M. pour-points and the significance of dewaxing paraffin-bearing oils are the main subjects of this paper. In the case of wax-bearing lubricating oils we have to deal with a two-phase system below the cloud-point, since, at this temperature, the wax begins to precipitate from the liquid. The quantity of wax present in a given oil, as well as the nature of the wax, whether crystalline or amorphous, determines the cloud-point and the pour-point.

ANALYSES OF TEST DATA

Fig. 1 shows the effect on the A.S.T.M. pour-point of the addition of wax to a partly dewaxed paraffin-base oil. This is a straight-line relation. The wax added was some of the same that was taken out in the dewaxing process. It should be noted that a small addition of wax makes a marked change in the pour-test of the oil so that, in dewaxing to obtain a zero-pour-point oil, the refiner is dealing with small quantities of wax at temperatures below 15 deg. fahr.

The three curves in Fig. 2 represent the behavior of an oil at three different temperatures: +10, zero, and —10 deg. fahr. The tests were made with an A.S.T.M. grease penetrometer. The effect of the wax becomes more pronounced at lower temperatures. As the tem-

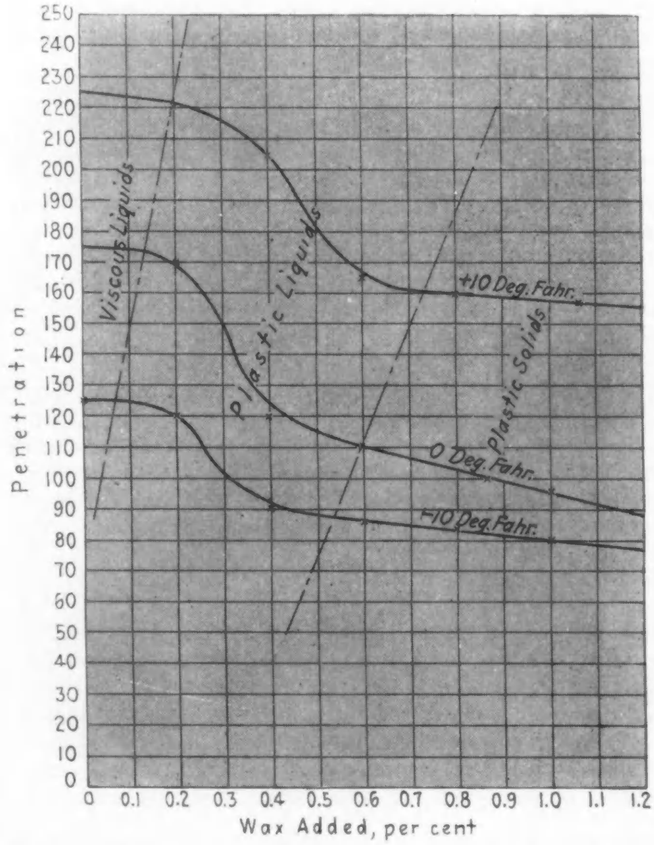


FIG. 2—EFFECT OF ADDED WAX ON THE A.S.T.M. PENETRATION

[4] See S.A.E. JOURNAL, February, 1928, p. 213.

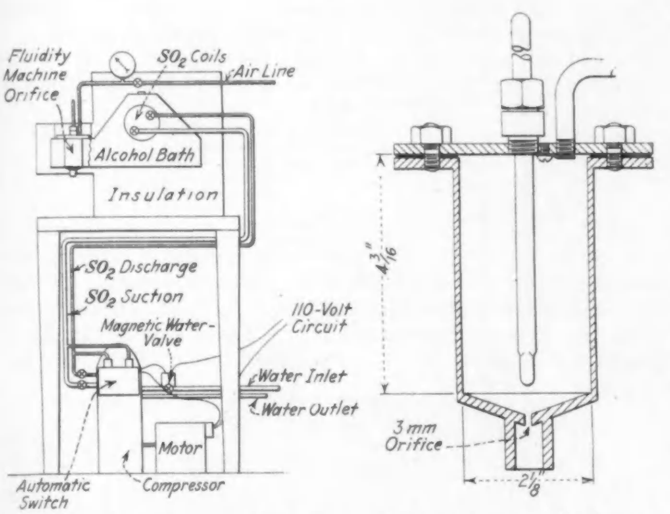


FIG. 3—DIAGRAM OF FLUIDITY MACHINE AND ENLARGED CROSS-SECTION OF THE ORIFICE

perature of a wax-bearing oil is reduced, the consistency changes from that of a viscous to that of a plastic liquid and, finally, to a plastic solid. Fig. 2 can be divided into three zones which show the three states of the oil. It should be noted that, by reduction of the wax content from 0.73 to 0.53 per cent, or 0.20 per cent, the temperature at which the oil changes from a plastic liquid to a plastic solid is reduced from +10 to —10 deg. fahr., a difference of 20 deg., and that, as shown in Fig. 1, the difference in pour-points is only 2 deg. fahr. This illustrates the importance of wax removal for low-temperature operation.

The great reduction in the temperature at which the oil changes to a plastic solid by a relatively small reduction in the wax content helps to explain why the break-away torque in cranking is as much as 50 per cent greater for a partly dewaxed oil than for a similar oil of lower pour-point, even though the effort required to continue the piston motion is the same for the two paraffin oils. The oil is a plastic solid as the piston breaks away, becomes a plastic liquid as the motion continues, and finally becomes a viscous liquid.

FLUIDITY MACHINE AND TEST RESULTS

The apparatus used in this work is shown in diagrammatic form in Fig. 3. It consists of a modified viscosimeter immersed in a bath capable of reducing the temperature of the oil to —30 deg. fahr. The oil tube was made pressure tight so that air pressure could be applied. The temperature was taken by a low-temperature A.S.T.M. cold-test thermometer, the bulb of which was immersed near the orifice. All determinations in this machine were made under a pressure of 7 lb. per sq. in. The temperature was slowly reduced and the time in seconds, as measured by a stop-watch, required to deliver 60 cc. of the oil, corrected to a temperature of 60 deg. fahr., was determined at the various temperatures. The quantity of oil delivered was weighed and its volume calculated from its specific gravity.

In Fig. 4 the effect of adding wax to a partly dewaxed oil is shown by running the samples at three different temperatures in the fluidity machine. The oil used was made from paraffin-base Ranger crude, the wax added being some of that taken out in the Sharples dewaxing process. From the shapes of the curves it will be noted that the wax content of the oil becomes more apparent at low temperatures.

Fig. 5 shows the comparative fluidities of three kinds of Grade 1 aero oils and an oil produced from a California crude. Curve No. 4 shows the fluidity of a California naphthene-base oil of 60-Saybolt-sec. viscosity at 210 deg. fahr. It is shown merely as a representative oil from this type of crude and is below the viscosity range of the three other oils shown. The Pennsylvania oil, No. 3, having a pour-point of 20 deg. fahr., shows a better fluidity than the asphalt-base oil, No. 2, having a 5 pour-point, while the paraffin-base Ranger crude, No. 1, having a zero pour-point, shows the best fluidity-curve. The A.S.T.M. pour-points of these oils are shown at the right of Fig. 5, as are also the temperatures at which the oil ceases to flow under a pressure of 7 lb. per sq. in.

Fig. 6 shows a similar series of curves for Pennsylvania and Ranger paraffin-base and for Coastal oils having viscosities corresponding to Grades 2 and 3 aero oil. The pour-point of the Pennsylvania oil, No. 3, is high, being 40 deg. fahr., and is therefore incompletely dewaxed. The pour-point on the Ranger and the Coastal oils, Nos. 1 and 2, is +10 deg. fahr. The curves show that the fluidity of the Pennsylvania oil is better than that of the Coastal oil to —9 deg. fahr., at which point the curves cross. This is due to the wax content. The Ranger oil having a pour-point of 10 shows a better fluidity than either of the two other oils.

Fig. 7 shows a series of fluidity curves for oils from various crudes corresponding to Grade 4 Liberty aero oil. For this work three different oils from Pennsylvania crude are shown. Their pour-points, are +20, +15 and +35 deg. fahr. The Ranger oil having a 5

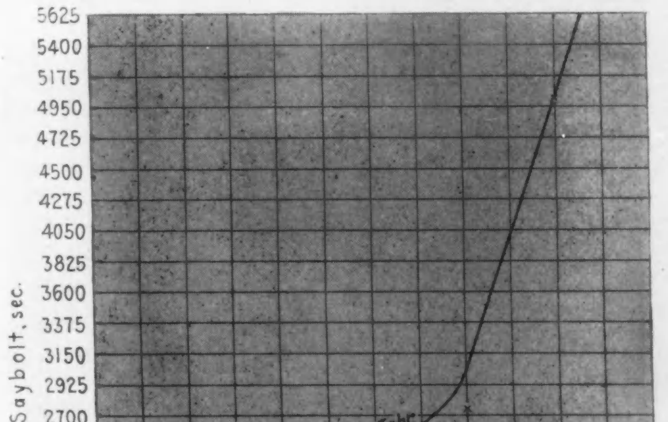
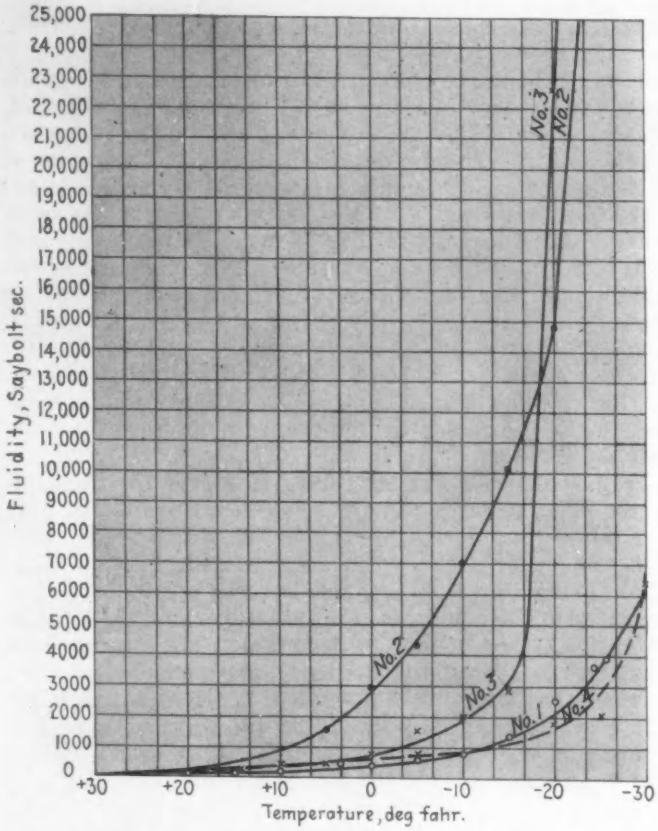


FIG. 4—EFFECT OF ADDED WAX ON THE FLUIDITY



pour-point shows the best fluidity curve; Pennsylvania No. 4, with a pour-point of 15, follows closely. Curves Nos. 3 and 5 represent partly dewaxed oils and show better fluidity than the asphalt-base oil to about +3 in

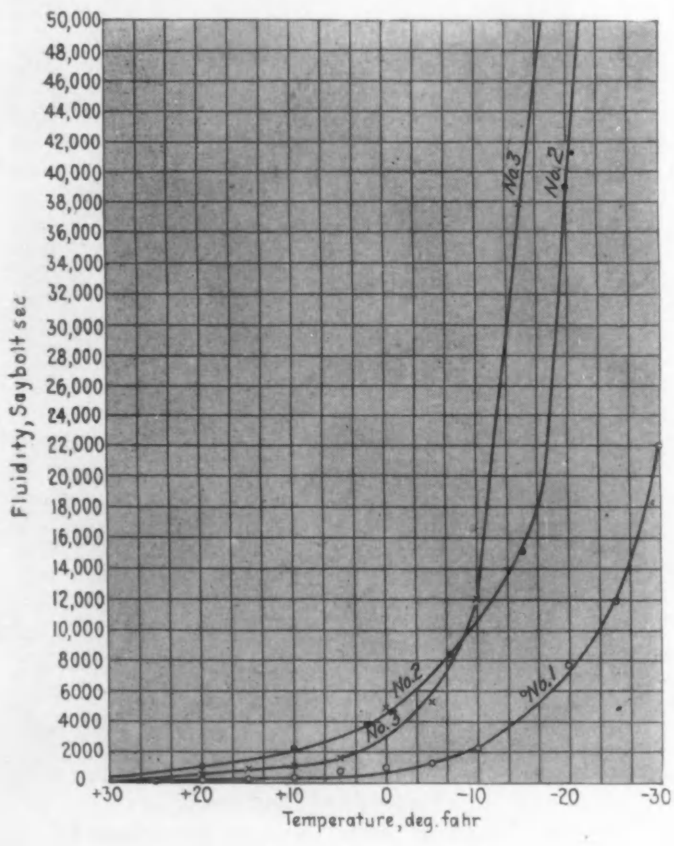


FIG. 5 (AT LEFT)—COMPARATIVE FLUIDITIES OF THREE KINDS OF GRADE 1 AERO OIL AND A CALIFORNIA OIL

The Tabulation Shows the Viscosity, the A.S.T.M. Pour-Points and the Temperatures at Which the Oils Cease To Flow Under a Pressure of 7 Lb. per Sq. In.

No.	Type	Saybolt Sec. at 210 Deg. Fahr.	A.S.T.M. Pour-Point	Solid Pour-Test at 7 Lb. per Sq. In.
1	Ranger	78	0	Below — 30
2	Coastal	78	5	— 25
3	Pennsylvania	80	20	— 30
4	California	60	0	Below — 30

one case, and —3 deg. fahr. in the second case. Curve No. 3 crosses Curve No. 5 at 4 deg. fahr. above zero, although the pour-point of No. 3 sample is at 20 deg. fahr. and that of No. 5 is 35 deg. fahr. This can be

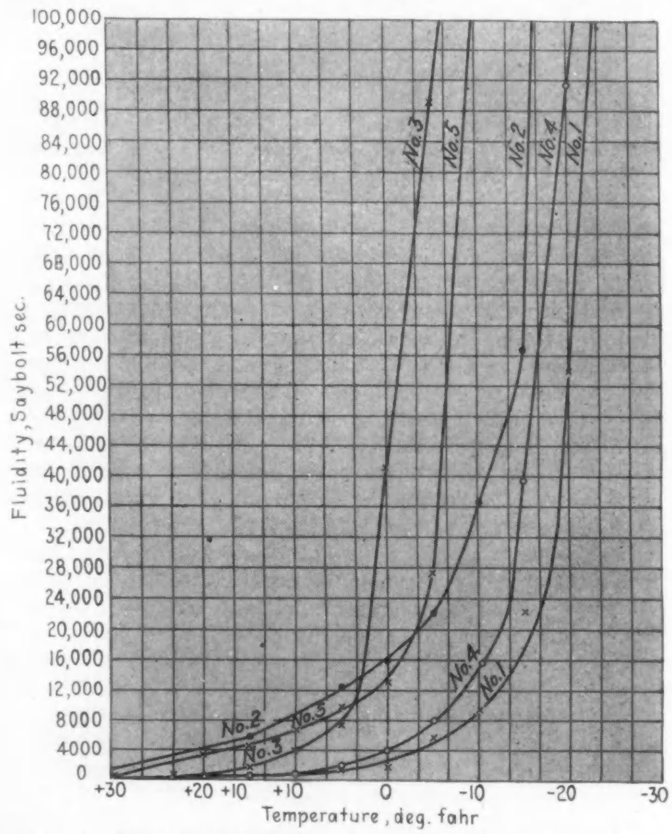


FIG. 7—FLUIDITY CURVES FOR OILS CORRESPONDING TO GRADE 4 AERO OILS

The Tabulation Shows the Viscosity, the A.S.T.M. Pour-Points and the Temperatures at Which the Oils Cease To Flow Under a Pressure of 7 Lb. per Sq. In.

No.	Type	Saybolt Sec. at 210 Deg. Fahr.	A.S.T.M. Pour-Point	Solid Pour-Test at 7 Lb. per Sq. In.
1	Ranger	121	5	— 25
2	Coastal	121	25	— 20
3	Pennsylvania	120	20	— 10
4	Pennsylvania	120	15	— 25
5	Pennsylvania	117	35	— 10

FIG. 6 (AT LEFT)—CURVES SHOWING COMPARATIVE FLUIDITIES OF GRADES 2 AND 3 AERO OILS MADE FROM ASPHALT-BASE AND PARAFFIN-BASE CRUDES

The Curves Are Similar to Those of Fig. 5, the Viscosities Corresponding to Grade 2 Aero Oil. The Tabulation Shows the Viscosity, the A.S.T.M. Pour-Points and the Temperatures at Which the Oils Cease To Flow Under a Pressure of 7 Lb. per Sq. In.

No.	Type	Saybolt Sec. at 210 Deg. Fahr.	A.S.T.M. Pour-Point	Solid Pour-Test at 7 Lb. per Sq. In.
1	Ranger	93	10	Below — 30
2	Coastal	93	10	— 25
3	Pennsylvania	90	40	— 25

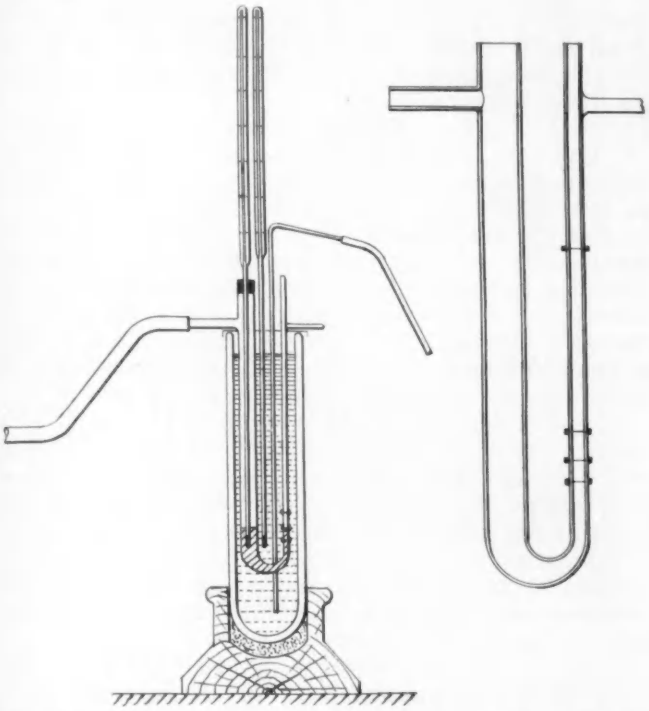


FIG. 8—VOGEL APPARATUS FOR DETERMINING THE TRUE TEMPERATURES AT WHICH AN OIL BEGINS TO FLOW AFTER IT HAS BEEN SOLIDIFIED

explained by the nature of the wax; a crystalline wax will show a different behavior at low temperatures than does an amorphous wax.

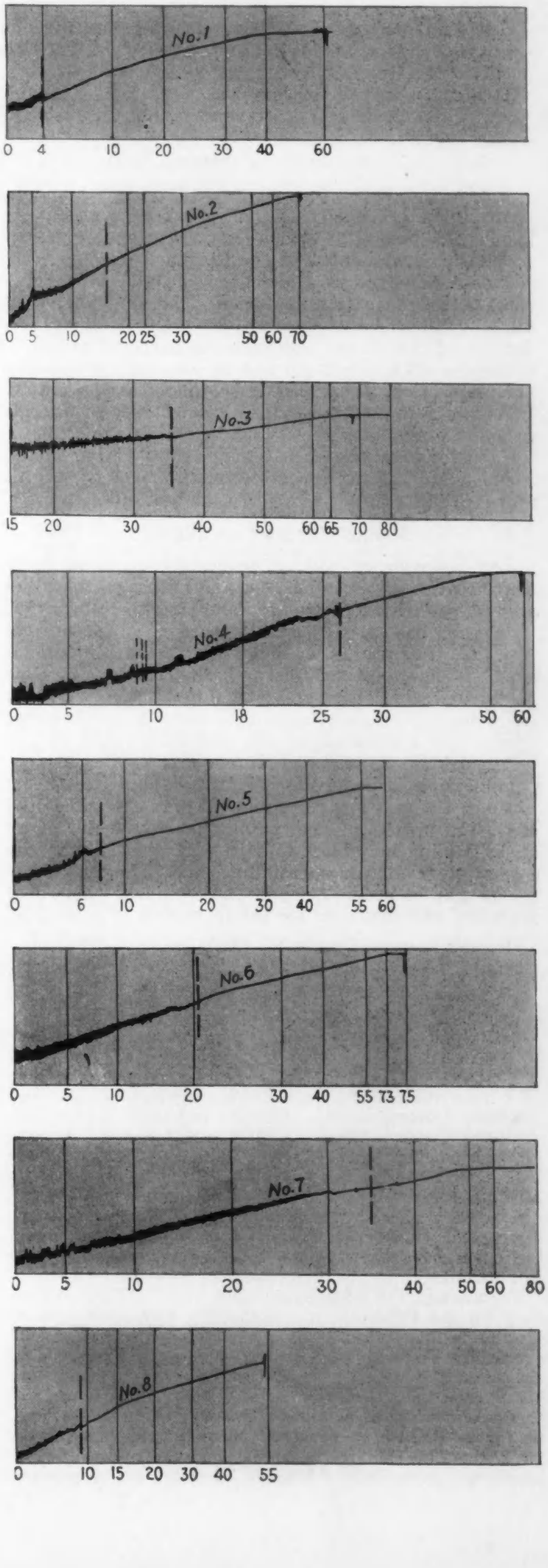
OIL CONSUMPTION

The quantity of oil consumed by an airplane engine per flying hour is important for reasons of economy and safety. Oils produced from different crudes vary in their physical and chemical properties. In general, paraffin-base oils show higher flash and fire tests, and consequently lower volatility, than do asphalt-base oils. The flash test is an indication of the volatility of an oil. There are several other laboratory tests designed to show volatility or evaporation loss, but the most satisfactory way is to measure the oil consumption in actual-flight tests.

The methods used to refine the crude oil will affect the properties and performance of the finished oil. This is especially true of the distillation process used. The oil may be a continuous chain of closely fractionated hydrocarbons of progressive boiling-points as the originally occur in the crude, or it may be a blend of a bright stock and a neutral oil, which usually shows a lower flash-point and a higher volatility than any unblended oil. The oil consumption will vary with the viscosity of the oil used.

FIG. 9 (AT RIGHT)—CONSISTOMETER CHARTS

No.	Type	Saybolt Sec. at 210 Deg. Fahr.	A.S.T.M. Pour-Point
1	Ranger	93	10
2	Blend of Midcontinent Cylinder-Stock and Neutral	93	10
3	Pennsylvania	100	35
4	Blend of Pennsylvania Cylinder-Stock and Neutral	100	40
5	Ranger	120	10
6	Blend of Midcontinent Cylinder-Stock and Neutral	113	20
7	Pennsylvania	120	40
8	Pennsylvania	118	20



The United States Government specifications for Liberty aero oils have three viscosity ranges; namely, Grade 1, 75 to 85; Grades 2 and 3, 90 to 100; and Grade 4, 115 to 125 Saybolt sec. at 210 deg. fahr. In this Country, Grades 3 and 4 are most widely used for air-cooled engines.

Stability in Service

Sludge and carbon formation due to oxidation and decomposition are detrimental to good lubrication. An excessive quantity of either may cause engine failure or at least make frequent overhauling necessary. The carbon-residue test is a laboratory method which indicates carbon formation in service. The solubility of the oil in sulphuric acid denotes the sludge-forming tendencies of the oil and indicates the grade of purity to which the oil was refined. As in the study of oil consumption, most large consumers of oil make actual-flight tests over an extended period and thoroughly inspect the engine when it is taken down to determine the amount of carbon-formation and the sludging effects. Poor mechanical and operating conditions of the engine may cause decomposition of even the best oils in service.

Other Methods of Testing

The behavior of oils at temperatures below their pour-point is very complicated and, although there are many types of instrument for studying their behavior, no method has as yet been standardized. The present A.S.T.M. pour-test is no indication of the behavior of an oil at low temperatures. Check tests on the same oil by the same observer or by different testers using the same method show large discrepancies, proving that results are influenced by the individual skill of the tester and the manner and the speed of cooling the oil. Complications arise in the case of paraffin-base oils because of the wax structure and the wax content of the oils. The process of determining the pour-point of an oil by cooling is subject to criticism, especially in the case of oils containing crystalline wax. This is because the oil may be under-cooled or shock-chilled, which does not allow sufficient time for the formation of crystalline wax. The oil also contains amorphous wax; so it is possible to obtain a pour-point lower than the actual solidification-point of the oil. This difference is due to variation in operation.

Dr. H. Vogel, of Hamburg, Germany, has developed an apparatus, shown in Fig. 8, and a method for determining the true temperature at which an oil begins to flow after it has been solidified[5]. Dr. Vogel's theory is that the temperature at which a paraffin lubricant passes from the solid into the liquid state can be determined *accurately*. His procedure is virtually a reversal of our pour-point determination. He preheats the oil to 50 deg. cent. (122 deg. fahr.), cools it first to room temperature and then, in an alcohol bath to which he adds solid carbonic acid, further to —30 deg. cent. (—22 deg. fahr). By applying the pressure of a 60-cm. column of water, he observes the temperature at which the oil surface in the U-tube rises. The mean temperature of the oil and of the alcohol bath, at this point, is the true flow-point of the oil. With the aid of this apparatus it is also possible to observe the actual fluidity of an oil near its true flow-point and at low temperatures, by determining the viscosity in centipoises at such temperatures.

A series of charts made on various types of oil by the Consistometer Laboratories apparatus is shown in Fig. 9. This apparatus consists of a small horizontal motor-driven propeller that rotates in a bowl, around the periphery of which are fins. The oil is cooled by a bath around the bowl. As the temperature is reduced, the consistency of the oil causes vibration of the bowl, and this vibration is recorded on the chart.

Rapid strides are being made by the petroleum industry in the manufacture of aircraft-engine oil and much attention is being given to the development of such oils by the refiners. The necessity for dewaxing paraffin-base oils and for their fractionation to obtain a close-cut homogeneous product has resulted in the development and installation of new types of equipment for both steam and vacuum distillation of lubricating oils. These developments are of great importance for the development of all high-speed, high-compression, internal-combustion engines.

[5] See *Erdol und Teer*, vol. 3, No. 33.

Economics in the Engineering Curriculum

WHATEVER educational theories we may hold, it is fairly evident that, for the present at least, the time available for engineering education is limited, and we are not likely for some time to follow the lead of law and medicine in placing engineering education upon a graduate basis. The reasons for this have been ably developed by Mr. Wickenden. It is of highest importance that we recognize at once the relative value of liberalizing topics as affecting the engineer and proceed to incorporate them in the engineering curriculum so far as the student's time will permit.

Fortunately, the investigation just completed by the Society for the Promotion of Engineering Education is quite definite on this point. While graduate engineers suggested a considerable range of desirable subjects of a liberalizing character, the majority recognized English, economics and history and their variations as of primary importance, and this agrees with the opinions of many thoughtful teachers. So far as English is concerned, there is unanimous agreement that the ability to speak correct English and a knowledge of the field of English literature are of primary importance; and the particular content and methods of presentation have for some time been discussed and studied by those interested. The case of economics and history, however, presents a somewhat different aspect which is just beginning to receive careful consideration.

If inquiry is made of any number of practicing engineers, or in fact of any number of engineering teachers, as to what their conception of economics is with reference to university instruction, a wide range of opinion will be disclosed. One group will define it in terms of international relations and world politics; another group visualizes this content as the science of government, with its related problems such as distribution of wealth and labor problems. A third group, and a growing one, will stress the economics of production and the application of the laws of economics, which are now taught in a more or less abstract manner, to the difficult problems of modern industrial management. A fourth group defines the desired content as accounting and cost finding and the more direct applications of this branch of industrial economics.—Dean Dexter S. Kimball, in *McGraw-Hill Book Notes*.

Atmospheric Humidity and Engine Performance

By Arthur W. Gardiner[1]

Annual Meeting Paper — *Illustrated with* Diagram and Charts

SO-CALLED correction factors to compensate for variations in atmospheric temperature and pressure have been in practical use in connection with engine testing; but the influence of the varying amount of aqueous vapor present in the atmosphere has not had sufficient consideration. The author submits brief test-data indicative of the effect of humidity on some factors of engine performance and of the feasibility of using rational power-correction factors. By assigning due importance to the effect of humidity, he believes that a more satisfactory anlaysis of car and of engine performance can be obtained.

Using a single-cylinder engine operated at full throttle and 1000 r.p.m. under stabilized conditions, tests were made observing maximum-power, air-flow, fuel-flow, detonation and spark-advance requirements over a wide range of relative humidity for an air-intake temperature of 100 deg. fahr. Curves made from the data obtained are given and discussed.

In conclusion, the author says the data show that humidity should be taken into consideration in engine and automobile test-work because of its relatively important effect on maximum power, spark-advance requirements, carbureter metering-characteristics and radiator peformance, and its lesser but measurable effect on detonation. Further, he asserts that the tests reasonably substantiate rational power-correction factors.

THE need for taking atmospheric conditions into account in engine-test work has, in general, been recognized, and empirical and rational considerations have led to the practical use of so-called correction factors to compensate for variations in atmospheric temperature and pressure by reducing power data to a common datum for comparison; but little or no consideration has been given to the influence of the varying amounts of aqueous vapor present in the atmosphere. This paper purposes to focus attention on humidity and shows the need for giving it consideration in engine-test work by submitting brief test-data indicative of the effect of humidity on some factors of engine performance and of the feasibility of using rational power-correction factors. By assigning due importance to the effect of humidity, it is believed that a more satisfactory analysis of car and of engine performance can be obtained.

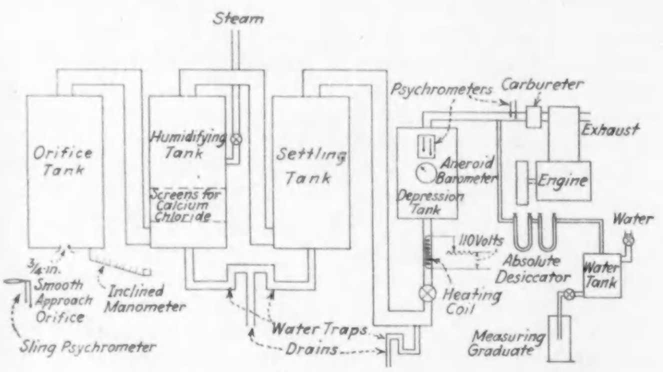


Fig. 1—Schematic Layout of Testing Apparatus

The tests, using commercial gasoline, were made on a single-cylinder variable-compression engine which had been conditioned immediately prior to the present investigation. The bore, stroke and displacement were, respectively, 3.28 in., 4.50 in., and 38.16 cu. in. The two overhead valves had a clear port-diameter of 1⅜ in., a lift of 11/32 in., and the following timing under running conditions: Inlet opened 9 deg. before top center and closed 32 deg. after bottom center; the exhaust opened 35 deg. before bottom center and closed 3 deg. after top center. The Stromberg Model OS-1 horizontal carbureter, with fixed metering jets and a ½-in. venturi, was mounted close to the intake port and supplied with fuel under a gravity head averaging 41 in.; the float chamber was balanced against the pres-

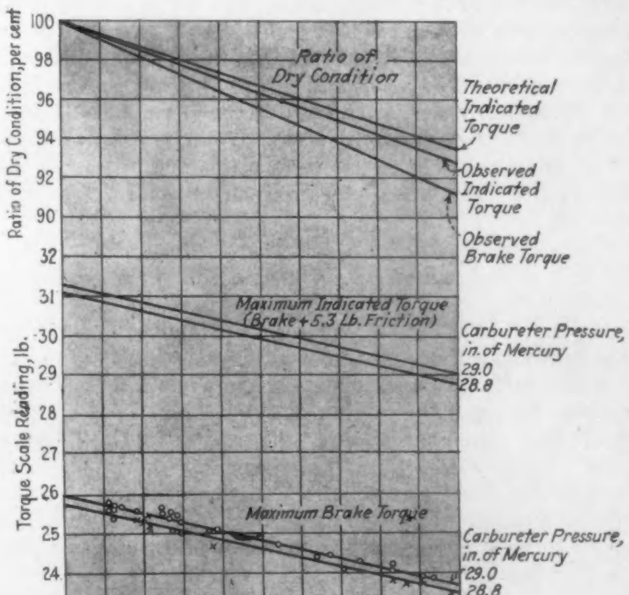


Fig. 2—Maximum Power

[1] M.S.A.E.—General Motors Corp. Research Laboratories, Detroit.

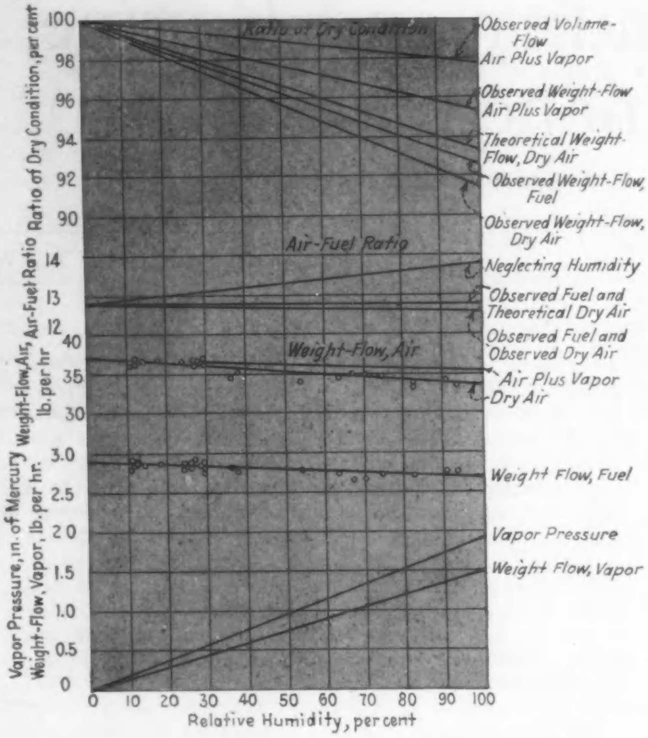


FIG. 3—AIR, FUEL, AND WATER-VAPOR FLOW-RATES

sure in the air duct. No heat was supplied to the intake manifold. A single AC Type E spark-plug, located between the valves, was used. The engine was connected to a 15-hp. electric dynamometer and was operated under the following sensibly fixed and stabilized conditions: (*a*) full throttle, (*b*) at 1000 r.p.m., (*c*) at a compression ratio of 5 to 1 giving a compression pressure of 90 lb. gage for a carbureter pressure of 29.0 in. of mercury, (*d*) at a carbureter air-intake temperature of 100 deg. fahr., (*e*) at a carbureter-air pressure of 29.0 in of mercury, (*f*) at an outlet-water temperature of 175 deg. fahr., (*g*) at a crankcase-oil temperature of 143 deg. fahr., and (*h*) at an exhaust back-pressure of 4 to 5 in. of water. The compression ratio was purposely chosen high to give marked but not excessive detonation at best-power spark-advance. A few tests were made at a carbureter pressure of 28.8 in. of mercury when the room barometer was so low that it did not permit the maintenance of 29.0 in. of mercury.

Spark timing was adjusted (*a*) at minimum advance for best power, and (*b*) for maximum advance for incipient detonation; test runs were made with these two settings. The fixed-jet carbureter gave fuel mixtures approximating those required for best power. The rate of water circulation was such as to give a temperature increase through the engine of from 17 to 19 deg. fahr. Speed was measured with a stop-watch and a counter; spark timing with a jump-gag indicator mounted on the crankshaft; fuel consumption with a graduated volume requiring about 100 sec. to empty. Friction was obtained by motoring the engine with controllable conditions as for the power tests.

The apparatus for measuring air, regulating moisture-content, and maintaining a constant temperature and pressure at the carbureter is shown diagrammatically in Fig. 1. A tube connected to the carbureter duct was used for drawing off a sample volume of air through an absolute desiccator, consisting of two U-tubes in series filled with a drying agent, for the purpose of calibrating the psychrometers under running conditions.

MAXIMUM POWER

The data plotted in Fig. 2 point to a definite and linear decrease in brake torque with increasing humidity. As no consistent variation in motoring friction was found, indicated torque is likewise seen to decrease linearly, approximately in accord with theory based on the relative decrease in weight of the dry-air charge. Theory indicates a total decrease of 6.6 per cent; whereas, the data indicate a decrease of 7.2 per cent in indicated torque. This agreement is fair enough to warrant the tentative conclusion that, for the condition in which spark advance and fuel-flow are maintained optimum for best power, indicated torque varies in accordance with theory. For an engine having a fixed spark-advance, the loss in torque would be greater.

The decrease in brake torque is about 8.8 per cent for this engine, which has a mechanical efficiency ranging from 83.0 per cent at zero to 81.5 per cent at maximum humidity. The effect of humidity on brake power would be relatively greater as the mechanical efficiency is lower. Power corrections for humidity thus seem to assume an importance equal to the usual corrections for barometric pressure. Methods for computing and applying these corrections are discussed later.

AIR-FLOW

Dry-air flow was obtained by correcting the measured orifice-flow for humidity conditions in the room. From Fig. 3 it can be seen that the measured decrease in weight-flow is about 8.5 per cent for the full range of humidity. This compares favorably with the theoretical 6.6-per cent decrease in air-flow and the observed 7.2-per cent decrease in indicated torque. The observed differences can be attributed to small errors in air-flow measurements, possible leakage of air into the induction system, and errors in the location of the faired curves.

By adding the computed vapor-flow to the observed air-flow and dividing by the moist-air density at the carbureter entrance, the volume-flow of moist air is obtained. These conditions point to a decrease in volumetric efficiency, on a volume basis, of about 2 per cent at high humidity. Discounting this figure by the amount of the difference between the decrease in indicated torque and dry-air flow, a slight decrease in the volumetric efficiency is still apparent.

WATER-VAPOR FLOW

From the fundamental relations presented later, it can be seen that the weight, in pounds, of water vapor per pound of dry air is given by the equation

$$W_v / W_a = 0.6217e / (P - e) \quad (1)$$

where W_a and W_v are the weights, respectively, of dry air and of water vapor, e is the vapor pressure, and P is the barometric pressure.

Using this equation and a vapor pressure of 1.926 in. of mercury (see Fig. 4), a figure of 0.0443 lb. of vapor per lb. of dry air is obtained for saturated conditions at 100 deg. fahr. Assuming that the observed flow of dry air is 33.9 lb. per hr., the maximum weight-flow of vapor works out to be 1.5 lb. per hr. This equals slightly more than one-half the weight-flow of fuel, which is an appreciable percentage. Curves of vapor flow and vapor

pressure are shown in Fig. 3, each being, by definition, proportionally variable with relative humidity.

The weight-flow of moist air is shown in Fig. 3. A decrease of 4.6 per cent is noted. This qualitative change results from the fact that the density of water vapor is only 62 per cent of that of dry air; so, for equal volumes inducted by the engine, the total weight of air-vapor charge is reduced at increasing humidity. Theory indicates a reduction in weight-flow of only 2.5 per cent. The observed decrease in volume-flow has been commented on previously.

Fuel-Flow and Air-Fuel Ratios

Because of the change in moist-air density flowing past the fuel jet, some change in flow rate of the fuel would be expected. The curves in Fig. 3 show a decrease of about 7.3 per cent at high humidity, the decrease being in about the same ratio as indicated torque. There is thus virtually no change in indicated specific fuel-consumption. If fuel-flow were assumed to vary as the square root of the moist-air density, a decrease of only 1.4 per cent would be expected. This marked effect of humidity on carbureter metering is noteworthy.

The observed ratio of dry-air flow to fuel-flow varies but slightly with humidity, the ratio decreasing from 12.8 to 12.6 for the full range. If observed fuel-flow were used and humidity neglected in estimating air-flow, the ratio would increase from 12.8 to 13.8. Hence the need is seen for considering humidity in determining exact mixture-ratios. In this connection, the significant ratio is that of dry air to fuel, by weight, as this establishes the proportions for chemical combination.

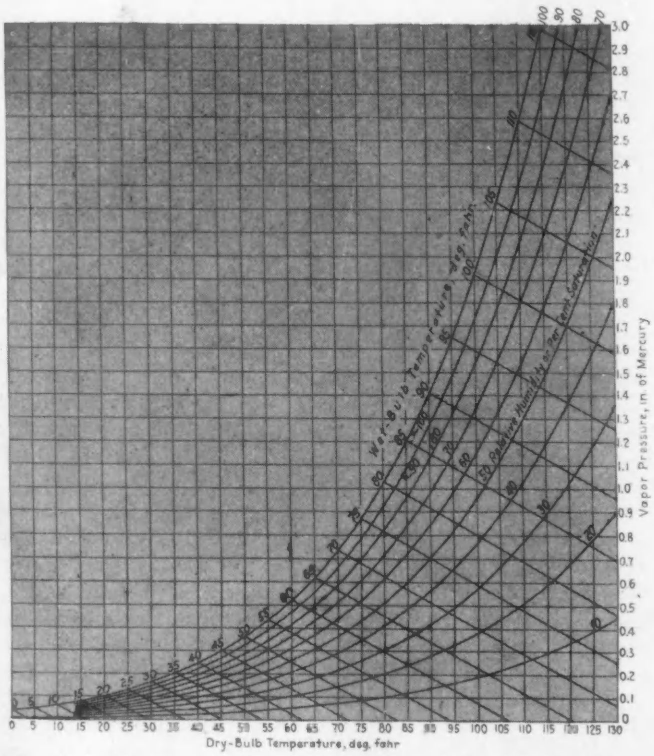


Fig. 4—Humidity Chart Giving Vapor Pressure Directly from Psychrometer Readings

The Chart Is for a Barometer Pressure of 30 In. of Mercury. Saturated-Vapor Pressures Were Obtained from Marks' and Davis' Steam-Table. Equation for Vapor Pressure—United States Department of Agriculture, 1900—for Ventilation Velocities past the Wet Bulb of 3 Meters per Sec. or More Is

$$e = Pt_1 - 0.000367\,P\,(t - t_1)\,[1 + (t_1 - 32) / 1571]$$

where

e = Existing Vapor-Pressure, in Inches of Mercury

Pt_1 = The Saturation Pressure at the Temperature t_1, in Inches of Mercury as Taken from a Steam Table

P = Barometer Pressure, in Inches of Mercury

t = Temperature of the Dry Bulb

t_1 = Wet-Bulb Temperature

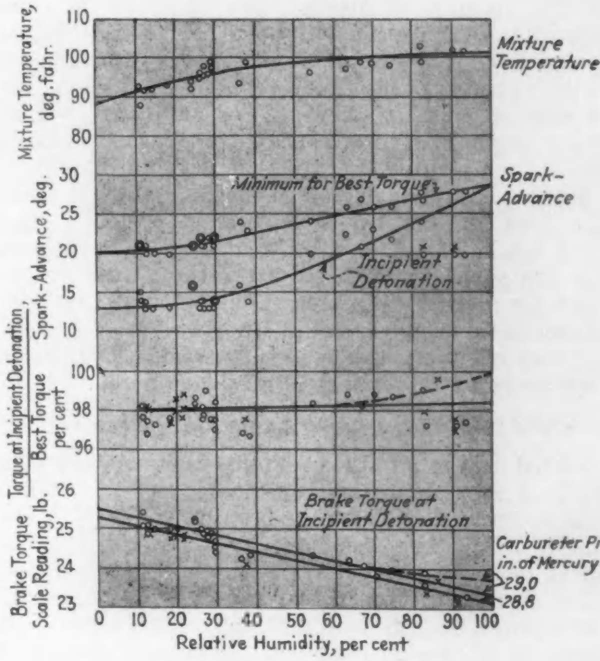


Fig. 5—Detonation and Spark Advance

Detonation and Spark Advance

Data on minimum spark-advance for best power, the advance for incipient detonation, and mixture temperatures, are shown in Fig. 5, together with brake torque-load for incipient detonation.

A large increase in spark advance is required to obtain best power at high humidity. If, for best power, maximum combustion-pressures are assumed to occur from 20 to 25 deg. after top center, it can be estimated that the time for combustion is increased about 20 per cent because of the presence of water vapor. This slowing-up of the combustion rate under damp-air conditions results in "smoother" engine operation, which is often mistaken for improved power. The failure of a fixed spark-advance to meet requirements is evident.

Increase in permissible spark-advance for incipient detonation is even greater. Whereas, under dry-air conditions the advance is approximately 7 deg. less than that for maximum power, under maximum humidity there is little difference in the advance for the two conditions. The effect of water vapor in suppressing detonation is indicated to some extent by the relation of these curves of spark advance.

The data on brake load at incipient detonation show a definite decrease with increase in humidity. The general trend of the curves is parallel to the curves for maximum torque shown in Fig. 2. However, certain of the tests at high humidity are evidently in error as judged by the low spark-advance therefor. Neglecting these points, the percentage ratio of torque at incipient detonation to best torque increases at high humidity, approaching 100 per cent. It seems that water, introduced as vapor, is relatively ineffective in suppressing

detonation, in spite of marked slowing-up of the combustion rate. A more conclusive test would be to establish permissible compression-ratios for varying amounts of water vapor. From the foregoing discussion, the importance of making allowance for humidity in tests involving determination of spark advance is evident.

Mixture temperatures increased at high humidity. The increase is explainable on the basis of the increased specific heat of the air-vapor charge. Hence, fuel vaporization has a lesser effect on the charge temperature at the port. In addition, the ratio of fuel weight to moist-air weight decreases. This increase in mixture temperatures may account, in part, for the negligible effect of water vapor in suppressing detonation and the decrease in volumetric efficiency noted.

Cooling-Water Losses and Radiator Performance

Measured heat-loss to the cooling water remained substantially a constant ratio of indicated power. Hence there is an increase of approximately 8 per cent in the amount of heat to be dissipated by a radiator for the change in humidity from 100 per cent to zero. For this direction of change, the cooling capacity of a radiator increases proportionally with air density, or 2.8 per cent. The product of specific heat and air density decreases with decrease in humidity, causing a reduction in the heat-transmission coefficient and a decrease in the average temperature-difference, water to air. These latter factors more than offset the beneficial effect of the increased air-density. Qualitatively, then, a radiator of sufficient capacity under humid conditions may not prove satisfactory under dry-air conditions.

Power Correction-Factors

For small changes in pressure, both atmospheric air and water vapor can be assumed to behave in accordance with the laws for perfect gases, including Dalton's law of partial pressures. Observed barometric readings thus represent the sum of the partial pressures of dry air and

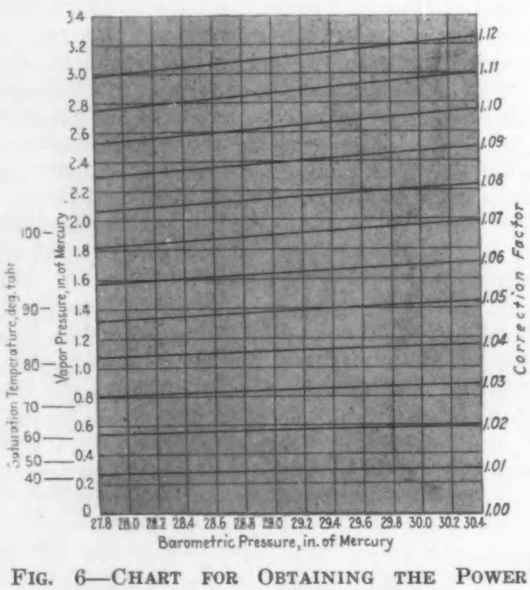


FIG. 6—CHART FOR OBTAINING THE POWER CORRECTION-FACTOR FOR HUMIDITY

The Correction Factor Is $P/(P-e)$, Where P Is the Observed Barometer Pressure and e Is the Vapor Pressure, in Inches of Mercury. This Is Based on Datum for a Standard Humidity of Zero, or 100 Per Cent Dry Air

water vapor. Further, the characteristic gas equation, $PV = WRT$, shows that the partial pressure of a given constituent defines its weight in a given volume of mixture. Using gas constants of 53.34 for air and 85.8 for water vapor, we have

$$W_a = 1.326\ (P - e)\ V/T \quad (2)$$
$$W_v = 1.326\ (0.6217e)\ V/T \quad (3)$$
$$W_m = 1.326\ (P - 0.378e)\ V/T \quad (4)$$

where W_a, W_v and W_m are the weights, in pounds, of dry air, of the water vapor and the mixture respectively in a given volume, V, of mixture for a given temperature, T, in degrees fahrenheit, absolute; P being the total pressure, e the partial pressure of vapor, and P-e the partial pressure of dry air in inches of mercury. The theoretical weight of dry air in the mixture is thus proportional to its partial pressure, P-e.

As an engine under given conditions can be assumed to induct a constant volume of air-vapor charge, and as, for small changes in operating conditions, indicated torque can be assumed to vary proportionally with the weight of dry air, it follows that torque varies proportionally with dry-air pressure, P-e. This forms the basis for obtaining rational power correction-factors. Assuming a standard for humidity of zero, the correction-factor for humidity equals $P/(P\text{-}e)$.

Correction factors given by the equation $P/(P\text{-}e)$ are plotted in Fig. 6, with vapor pressure, e, and barometric pressure, P, as arguments. As dry air is seldom encountered, it might be more logical to assume a standard for humidity other than zero, but the chosen datum is to be recommended as being definite.

Instead of correcting for humidity independently, a combined correction can be employed, in which the pressure of dry air, P-e, is substituted for the barometric pressure, P, in the power correction-factor for pressure. Thus, the correction factor for humidity and pressure is $29.92/(P\text{-}e)$. Corrections should be determined for conditions at the carbureter entrance.

Determination of Water-Vapor Pressure

The foregoing considerations involve determination of the water-vapor pressure, e. As the usual humidity charts do not give direct values for vapor pressure for all conditions, Fig. 4 is submitted. This chart is based on the equation shown underneath it as developed for psychrometers having ventilating velocities of 3 meters per sec. or more; and is drawn up for a constant barometer of 30 in. of mercury. Saturation pressures have been taken from Marks' and Davis' steam tables. To use this chart or equation, the ventilating condition must be fulfilled, if accurate results are to be obtained. As, strictly speaking, the chart in Fig. 4 is correct for but one barometer, the chart in Fig. 7 is submitted, which can be used to correct values taken from Fig. 6 for different barometer-readings. In general, values taken from the chart in Fig. 4 can be used directly, particularly as errors in the use of the wet-bulb and the dry-bulb psychrometer may easily be in excess of the error involved by omitting the barometer correction in ascertaining the value of e.

Variation of Atmospheric Humidity

To give a general idea of the amount and variation in the water-vapor pressure in the atmosphere, the curves in Fig. 8 are submitted. Data for these curves were obtained through the courtesy of the Detroit station of the United States Weather Bureau. The daily fluctua-

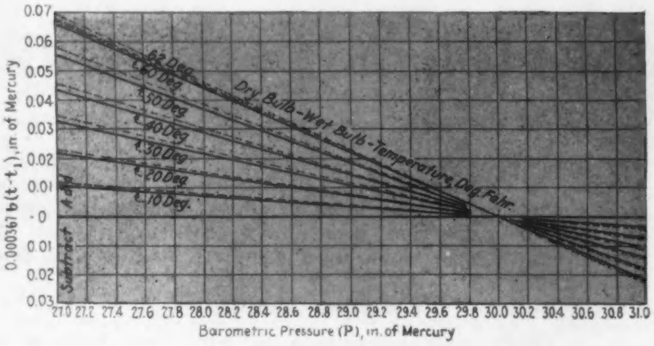


FIG. 7—CHART FOR USE WITH THE CHART IN FIG. 4 TO CORRECT FOR DIFFERENCES IN BAROMETER

The Correction, in Inches of Mercury, Is To Be Added—with Proper Algebraic Sign—to Values for Vapor Pressure Taken from the Chart in Fig. 4. The Approximate Correction Is Obtained from the Equation Given for Fig. 4 by Omitting the Small Factor $(t_1 - 32) / 1571$ in the Addition Correction. The Solid Lines Indicate Approximations. The Dash Lines Show the Exact Correction for the Maximum Value of t_1 To Be Found on the Chart for Fig. 4 for a Given Value of $t - t_1$, Showing the Maximum Order of Error by Excluding the Factor $(t_1 - 32) / 1571$. P Represents the Existing Barometer-Pressure and $b = 30 - P$. The Temperatures Are in Degrees Fahrenheit

tions in dry-air pressure are seen to be appreciably greater than the variations in barometric pressure. Further, whereas barometric pressure shows no consistent change throughout the year, the dry-air pressure decreases noticeably during the summer months. It can be seen that daily and seasonal power-fluctuations occur that are not accounted for in making the usual pressure and temperature corrections.

The magnitude of the vapor pressure shown represents the minimum. In the test room, where higher temperatures and local steam-leakage and evaporation from the water cooling-system are possible and probable, considerably greater vapor pressures may be encountered.

CONCLUSIONS

To recapitulate, it has been shown that humidity should be taken into consideration in engine and automobile test-work because of its relatively important effect on maximum power, spark-advance requirements, carbureter metering-characteristics and radiator performance, and its lesser but measurable effect on detonation. Rational power-correction factors have been shown to be reasonably substantiated by test.

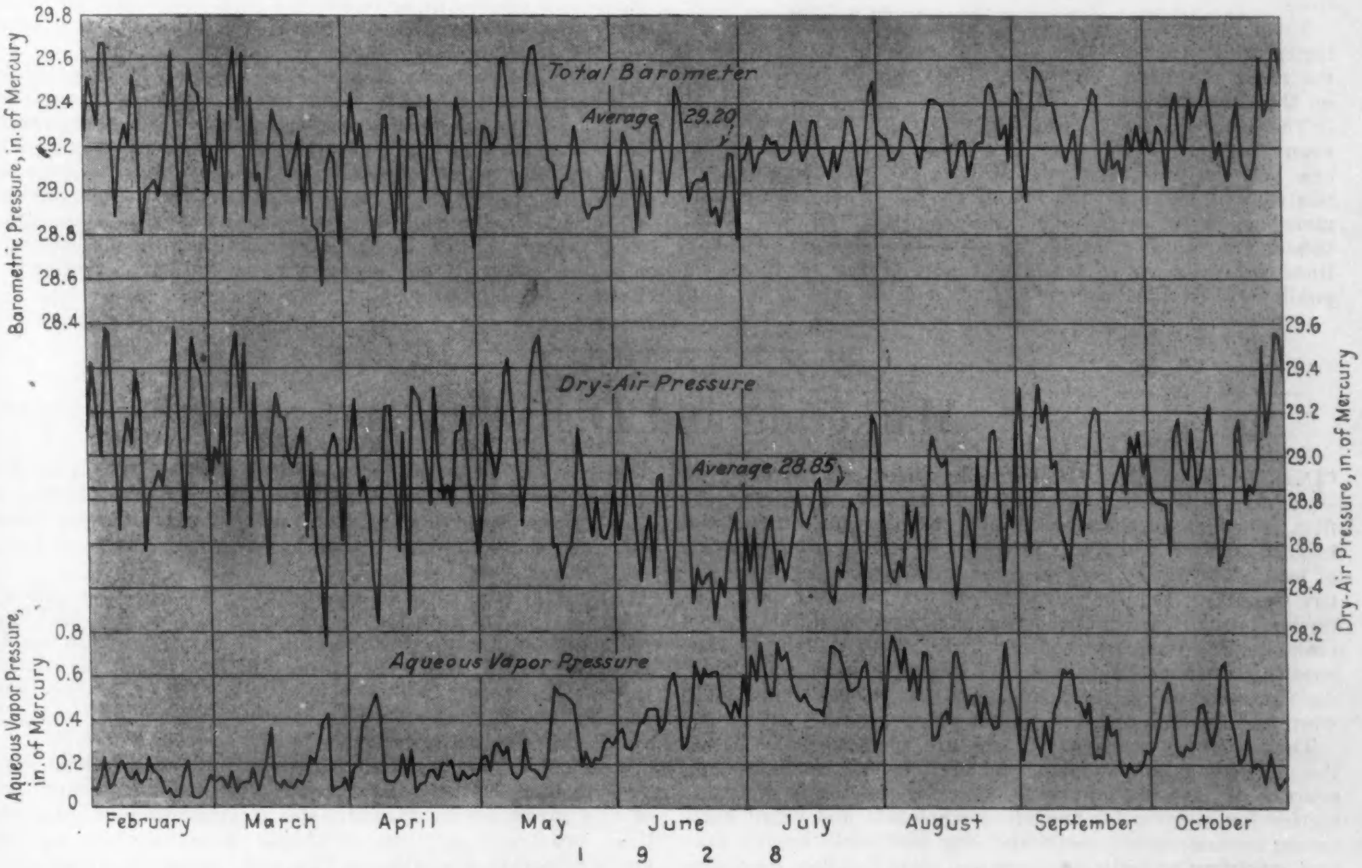


FIG. 8—ATMOSPHERIC PRESSURES FROM NOON OBSERVATIONS OF THE WEATHER BUREAU AT THE DETROIT STATION

The Airlines of Holland

CENTERED at Amsterdam and Rotterdam, the Royal Dutch Air Lines (K.L.M.) has services direct to London and Paris on its own lines and cooperates with foreign companies on lines to Bremen and Hamburg, Copenhagen and Malmo, Brussels and Bale. The London and Paris services constitute nearly half the traffic.

The year 1927 showed a very great increase in the business handled. The number of passengers doubled. Over twice as much parcel post was carried, nine times as much mail and 60 per cent more freight. The comparative record of the two years is as follows:

	Passengers	Mail, Lb.	Goods, Lb.
1927	12,816	41,390	920,310
1926	6,275	5,216	574,466

In 1927 the airplanes of the K.L.M. flew a total of 8187 hr., covering a distance of 1,310,000 km. (814,034 miles). Although the Deutsche Lufthansa and the Farman Company maintain services between Amsterdam and various other cities, the combined traffic of these two companies in and out of Holland is considerably less than that of the Dutch lines.

Until the end of the year the company's record for regularity of service was very high. During the summer season the mean regularity on its own lines was 98 per cent, and, on the cooperative lines, 97 per cent.

The company is making an effort to develop a year-round service. On its northernmost service, such as the one between Hamburg and Malmo, the short daylight in winter will make it difficult to fly the whole route until more adequate airways and lighting facilities are established. So far as possible, however, the company will continue operation in winter. It is now trying to dispel the public opinion that winter flyng is not as safe or as comfortable as summer flghts. The excellent meteorological service that prevails on most of these Continental routes provides adequate and accurate weather reports at all times. The planes themselves are both heated and free from draft.

Far-East Service

It is particularly interesting to note that Holland is extending its air service to the Far East. The K.L.M. is now organizing a route to Java and, by way of demonstration, one of the company's planes carried the American air-tourist Van Lear Black to Batavia and back, proving that a mail service to the East Indies is possible. Subsequent flights have also given evidence of the practicability of this service. A Dutch Indian air-traffic company, which will connect Holland with India, is said to be in process of formation.

Divided over eight different flying-grounds, the Royal Dutch Company's planes provided local flights for 15,253 passengers in 1927 as compared with 2464 in 1926. The company looks upon these otherwise insignificant operations as a method of advertising and of education, believing that this service has eliminated much of the prejudice against the supposed dangers of air traffic.

A more fundamental indication of the growing importance of aviation in Holland is found in the new subsidy contract which the company has arranged with the government. In the middle of the year, the Parliament authorized a subsidy law which definitely establishes the existence of the K.L.M. for the next seven years. In view of the growth of foreign competition in aviation, the company looks upon this subsidy as of the greatest importance if Holland's place in international aeronautics is to be maintained.—Bulletin of the Daniel Guggenheim Fund.

Marketing and Distribution

THE Department of Commerce has been concentrating its efforts on four or five major distribution problems, the first of which is the development of a series of regional market surveys which are intended to supply a compilation of basic data on the general commercial structure of the entire Country. For the purposes of these surveys the Country has been divided into nine regions based on differences in economic and business factors. The first of the series, that on the Southeastern States, has recently been completed. Similar surveys on New England, the Pacific and Southwest, and the Midwest are now in progress.

These surveys undertake to analyze what might be called the "consumer differences" in the various sections—the sources of income, influences affecting buying power, facilities for distribution including wholesale and retail marketing arrangements, merchandising and credit trends, factors involving advertising, store and plant location, merchandising methods, commodity preference and a host of other details which might contribute toward more efficient distribution. The president of a well-known Western company which covers 11 States in its operation has estimated that a similar report on his territory will save the larger firms doing business therein an aggregate of not less than $17,000,000 per year.

A special effort will be made in the New England report to cover the markets for industrial goods so as to indicate to local manufacturers as well as those outside that territory the volume and type of demand for industrial equipment. The report will also show the distribution of that section into 13 major trading areas, 39 secondary, and 130 retail shipping districts.

Particular attention is being given in these regional surveys to the question of commodity movements into and out of the given areas, through the collaboration of railway lines and truck services. Hitherto there has been almost no information available on this vital question of the flow of commodities.—Dr. Julius Klein, in *Trade Winds*, Union Trust Co. of Cleveland.

Short-Haul Passenger Transportation

Discussion of A. T. Warner's Transportation Meeting Paper[1]

SHORT-HAUL transportation of passengers is defined, for the purpose of the author, as traffic on lines on which the average ride is about three miles, on routes that traverse heavy-traffic streets through an area of dense population, where the operating speed is relatively slow and a large number of stops are made per mile.

Development of the motorcoach is traced briefly down to the modern city-type gasoline-electric coach, of which type the New Jersey corporation with which the author is connected now operates approximately 900. The advantages of this type for city service are dealt with, emphasis being placed on the elimination of gearshifting, which is a boon to the driver, results in important savings in maintenance and affords a safer and more comfortable ride for the passengers.

Seating arrangements are described for motorcoaches in which standee loads are carried, and an invitation is extended to engineers to submit practical suggestions for providing comfortable and usable passenger-seats over the wheel-housings that will enable retention of the standee "well" at the front part of the body.

The six-cylinder engine is said to be needed for its flexibility, greater power and acceleration as compared with the former four-cylinder engine; and it is asserted that power brakes are becoming practicable for all the larger motorcoaches. The gasoline-electric coaches, on which the driver has command of the hand brake, foot air-brake and electric brake, are believed by the author to be the safest vehicles using the roads.

The New Jersey Corporation is utilizing the same supervising, operating and maintenance organization for its motorcoaches as for its street-railway service, and experience is proving that this is right.

Since 1924 the motorcoach service has increased from 15,000,000 coach-miles operated and 76,000,000 passengers carried, to more than 55,000,000 coach-miles and 300,000,000 passengers anticipated for this year. One-half of the total transportation this year will be carried in the corporation's 1800 motorcoaches, and the other half in its 1400 street-cars. The service with both types of conveyance is coordinated and unified. Motorcoaches have been substituted for street-cars in two large cities in the State, and the service formerly furnished by street-cars on one-track lines in five other cities or towns is now given with motorcoaches. The place of the motorcoach in the transportation field is asserted to be broadening rapidly.

In the discussion, appreciation is expressed of the assistance given by the Society in the preparation of the motorcoach regulations of the State of New Jersey, and credit is given to the automotive engineers for the rapid development of the motorcoach to its present state. Criticism is made, however, of inadequate ventilation, uncomfortable seats, exhaust fumes in the body, noisy exhaust, and swaying hold-on straps for standees. Problems of seating arrangement in city-type coaches, of taxicab and jitney competition, route designation, and tire equipment are considered.

JOSEPH CRAWFORD[2]:—Meetings such as this, to discuss the motorcoach business, are sure to help us all. While we have needed considerable help during the last few years, we find that the situation is easing up now, because the engineers have taken hold of matters. They have produced an instrument that is superior in every way to what I was introduced to in 1915. If those of you who were in Newark when the first jitney started in the city will recall it to your own vision, then stand on Broad Street today and note the development that has taken place in the motorcoach field, you will agree with me that the engineer has done a wonderful job.

Mr. Warner spoke of cooperation by the municipalities. I will leave it to him whether Newark has cooperated in this matter; but we are going a step further. Director Brennan, of the Department of Public Safety, is about ready to install one of the best electrical traffic-signal systems in the Country. His position has been very difficult because Newark has so many T streets. We have but one cross street, barring Market Street, from Clinton Avenue to Central Avenue. It is Director Brennan's purpose to operate those signals in such a way that an automobile can go at least $1\frac{1}{2}$ miles on Broad Street at the rate of 21 m.p.h., and continue that rate without interruption if he keeps in step. I do not think there will be much difficulty in keeping in step, because 21 m.p.h. is about the average speed. It will be very interesting to watch how the motorcoaches make out. I know that when the system is in operation they will move a great deal faster than at present. There will be fewer delays, especially with the short-haul motorcoach.

The short-haul business can be likened to the human heart, for the purpose of this discussion, as it supplies life and energy to the business section of the community it serves. It brings to the business section the bone and sinew of the factory, the business house and the office building as represented by the mechanic, the office help, and the laborer.

Passengers Always in a Hurry

These employes must be adequately served with prompt and efficient transportation or they will become dissatisfied and seek employment elsewhere. The worker that I have in mind patronizes local transportation to a greater extent than does the employer, based on the percentage one bears to the other. He or she cannot afford the time necessary to locate a parking space on the streets for his private automobile, nor can he afford to pay for parking space. For these and other reasons the short-haul transportation service is the artery on which the worker must depend.

[1] Published in the November, 1928, issue of the S.A.E. JOURNAL. The author is general manager in charge of traffic for the Public Service Coordinated Transport, Newark, N. J. The abstract of the paper is reprinted herewith, supplemented by a summary of the trend of the discussion, for convenience of the reader.

[2] Supervisor of transportation, City of Newark, Newark, N. J.

Development of this business, if it is to be made profitable, depends to a large extent upon a keen knowledge on the part of the operating company of working conditions in the municipality served, such as the number of people employed in a given area and in each industry or business in that area, where they live, the routes that serve them best, and the hours of employment.

Still another factor that should be considered in relation to short-haul business is the shopper. In a populous community the shopper, as a patron of the short-haul lines, looks for the same adequate, efficient service. She also is in a hurry to reach the business section and to return home, and unless a reasonably fast service is rendered she may resort to the private automobile, especially since the larger department stores are maintaining parking facilities for her convenience.

The short-haul passenger is always in a hurry. He expects speed with safety. If he is delayed occasionally or frequently, he looks for some other means of transportation to meet his wants, and turns to the attractive low-price car.

Salesmanship Through Driver Courtesy

Salesmanship should be brought to the front by the short-haul motorcoach operator. This can be accomplished through the courtesy and personality of the drivers. Those possessing such virtues will soon gain the confidence of short-haul patrons, for it is unquestionably true that daily riders like to ride with drivers who extend unusual courtesies. This of itself creates a regular patron, and such patrons are the backbone of the business.

Another growing patronage in Newark is that of the occupants of apartment houses. Usually they are without private garages, and it is safe to assume that they would rather use public transportation, if it is convenient, than to walk several blocks to a public garage for their automobiles. This class of business should be studied carefully and the trade solicited.

The advent of the gasoline-electric vehicle undoubtedly has been a boon to the short-haul business. Drivers of coaches on short-haul lines feel the strain of their work, and every effort should be made to furnish them relaxation at the end of their trips. They carry an average of 1000 passengers per day, more by far than are met by salesmen in any other business; and, if we would show the driver the courtesy we expect of him, his life would be serene.

Route Designation Should Aid Strangers

It must be borne in mind that thousands of strangers visit a populous city during a day; to them the designation of the route by an individual word, usually the name of one street or section of the city, means nothing. Because of this, much business which should go to the short-haul lines is diverted to the taxicab service. Find a better way to advertise the individual short-haul lines. The numeral system has its advantages; it is simplest for the steady riders, but by catering to the visitor you not only advertise the service but the municipality as well.

Crosswise and longitudinal seats have been mentioned. The cross seat undoubtedly is a luxury, but is it not a fact that the short-haul passenger is desirous of getting in and out of a motorcoach quickly? That cannot be done either conveniently or rapidly with cross-seat construction. Let us consider this subject from the angles of rapid loading and unloading, extra space acquired through the use of longitudinal seats, and stabilizing the load at peak hours.

The first motor-bus ordinance in Newark was approved on May 12, 1916. Ten days later 24 permits were issued, and from then on a total of approximately 1800 licenses have been issued, of which 550 survive today. Operators who fell by the wayside did so because they had no knowledge of costs, mileage or depreciation. Every cent collected was regarded as profit, and notes were issued without thought of the judgment day. From all this has grown the present comprehensive short-haul system, with its large, well-constructed, well-lighted, and ventilated vehicles developed by the increasing efforts of the automotive engineers.

Society Helped in Drafting Regulations

Chairman Martin Schreiber[3]:—If a motorcoach operator obtains a permit from the municipality, it is still necessary for him to secure the approval of the Board of Public Utility Commissioners of the State of New Jersey. The commissioners have been all through the motorcoach development and have settled upon certain requirements as to operation and equipment. Mr. Eddy, engineer of the Commission, will now address us and I suppose will want to know why motorcoaches are sent into New Jersey with the doors in the sides when the State requires them in the rear, why the exhaust pipes shoot the gases out on the wrong side, why some of the coaches are too long and others too wide, and questions of that kind.

H. C. Eddy[4]:—Mr. Schreiber is mistaken in what I am going to say. I say those things six days in the week, sometimes seven, right along. One of my official duties is to have discussions with Mr. Warner and Mr. Schreiber. We have to take up these matters of operation, equipment, and so forth. We get together and thresh them out, and we have, to me at least, very interesting conferences, with, as a rule, very satisfactory results.

I have a particularly friendly feeling toward the Society of Automotive Engineers for the reason that a few years ago, when we were planning to draw up the specifications to which Mr. Schreiber referred, we called upon the Society to assist. It cooperated in every possible way, and gave us very valuable assistance and advice. It was in no small measure through this aid that we were able to produce a set of specifications that have proved to be more or less satisfactory. Since the first specifications were adopted by the Board, they have been twice amended; and in preparing those amendments we also sought and received the cooperation of the Society.

Mr. Warner stated in his paper that "the motorcoach of today is a refinement and re-design of the motortruck." It might also be stated that, judging from some of the vehicles one observes occasionally in traveling about the Country, there still remain a few buses which have not progressed very far through the refining process.

Concerning the gasoline-electric coach, it has been my observation that this type is by far the most satisfactory for city service and certainly the most popular with the public. We who are engaged in public-utility regulation, particularly as applied to transportation, have perhaps an exceptional opportunity to learn some-

[3] General manager in charge of plant, Public Service Coordinated Transport, Newark, N. J.

[4] Street railway engineer, Board of Public Utility Commissioners, State of New Jersey, Newark, N. J.

thing of the reaction of the public to various types of equipment. In addition to the much smoother operation of the gasoline-electric coach as compared with the straight gasoline type, I believe that the feature of comparative noiselessness is an additional reason for its popularity. Mr. Warner does not seem to be much in favor of the gasoline-electric type for long-haul service. It would be interesting to learn the reasons therefor.

Seating-Arrangement Problem Needs Solution

Design of the body of a city-type coach to accommodate a standing load is a most important feature to be considered, as it is generally agreed that at least a limited standing load should be allowed in city service during the rush periods. According to my observation, the type of body and the seating arrangement described by Mr. Warner are the most satisfactory for such service. By coincidence, there came to my desk by the same mail that brought Mr. Warner's invitation to partake in this discussion, a letter from an official of a town near by asking what is considered a proper standing load in proportion to the seating capacity. I took up a copy of Mr. Warner's paper, hoping to find the answer, but discovered that he had, no doubt wisely, failed to commit himself in the matter.

The problem of the cross seat over the wheel housing, with the seating arrangement suggested, is serious; the discomfort and inconvenience occasioned by this arrangement cause much complaint. The placing of a short, two-capacity, longitudinal seat over the wheel housing, utilizing cross seats otherwise in the rear section of the body, meets this situation in a more or less satisfactory way but is not the real solution of the problem.

The most economical method of maintaining and operating a transportation system, consistent with good service, particularly where vehicles of such vastly different character as the motorcoach and the street-car are operated under the same system, should be adopted in the interest of the public as well as of the operating company. If this can best be accomplished through coordination, in both the maintenance and the operation of the vehicles, that is the logical method to follow.

Safety of the vehicle and the conditions under which it has been found to be the most serviceable type are surely the most important considerations in the selection of the kind of vehicle to be used. The great increase in motorcoach traffic throughout the Country might be attributed to the establishment of many new lines serving territory not theretofore served, and also to the substitution of motorcoaches for street-cars in many instances. The fact is, however, that there is a general and decided demand by the traveling public for the motorcoach in preference to the street-car wherever the former can be operated advantageously. While the flexibility of the motorcoach as compared with the street-car, including the matter of curb pick-up and delivery, is a strong element in the popularity of this type of vehicle, I believe that the greatest factor is the psychology of the situation. Whether it be fancied or real, the majority of the riders undoubtedly believe that the motorcoach will take them to their destinations more quickly than any other means of public transportation, and quick passage is the first consideration of most riders.

The field of the motorcoach is broad and is still expanding. While the motorcoach has reached a high state of development, both in design and in field of usefulness, I have yet to see a vehicle that can handle mass transportation in our cities and larger communities today as efficiently and economically as does the modern electric car.

Rear-Exit Door Thought Unsafe

M. C. Horine[5]:—In connection with the rear-wheel-housing problem, has Mr. Warner any suggestions regarding a rear-exit door as a possible solution? This would tend to cause standees to gather at the rear, where the load is carried better than in the front, and would also give a circulating load.

A. T. Warner:—There is no doubt that such an arrangement would give a circulating load, but we are rather fearful about the use of a rear door from a safety point of view. I know that in many places the so-called treadle door in the rear is being used. We are still open-minded regarding it, but are afraid of the safety feature.

Mr. Horine:—I did not have reference to the method of operating the door. I am aware that in some cases the treadle-operated door has had unexpected results; but there are other means of operating the door that are under the control of the driver, governed by properly placed mirrors.

Mr. Warner:—If the mirror stays in place and the arrangement of standees and so forth is such that the individual who is driving is not blocked at all, the safety might be improved to some extent.

Then there is the matter of the collection of fares. How many people would beat their way in at the back door? That is important.

Taxicab and Jitney Competition

R. E. Plimpton[6]:—Can Mr. Warner give some idea of the possibility of combating the rising tide of more or less unregulated and destructive taxicabs that seems to be sweeping over the Country, either through a flat rate as found in some of the smaller cities, with a 25 or 50-cent fare to almost any part of the city, or the low-rate taxicabs which I noticed in Detroit recently? Some taxicab operators there have reduced their rate to 5 cents for each one-third mile, and at least two companies now charge 5 cents for one-quarter mile.

Detroit has also an example of the menace to the public-service transportation companies by the uncontrolled and unregulated jitney. The number of these has doubled or tripled in the last two or three months, according to estimates of various persons in Detroit. About 500 before that were protected by court decisions. I understand that there are now 1500 or more in service on various routes.

There seem to be two possibilities of meeting the situation: either operating a vehicle of the same size as the jitneys, to carry seven or eight passengers, or operating a 12-to-16-passenger vehicle that has high speed and good handling ability. The latter method is being tried on one of the suburban runs, and may be tried on the city runs. The main question is whether sufficient public demand exists to enable the present transportation company to operate the smaller vehicles without loss and still do something worth while for the public.

[5] M.S.A.E.—Manager, sales promotion department, Mack Trucks, Inc., New York City.

[6] M.S.A.E.—Associate editor, *Bus Transportation*, Chicago.

MR. WARNER:—Is it your thought to operate a different class of service, approximating taxicab service?

MR. PLIMPTON:—It should be something that would meet the taxicab competition and also perhaps cater more directly to the owner of the private automobile.

MR. WARNER:—I think undoubtedly a demand exists in select communities or in select sections of the city for a better class of service than the ordinary vehicles give, call it de luxe service or super-service. We have several such lines. They have been laid out to tap the better-class residential sections. The fare is double that of the other transportation. Special vehicles are used on them, painted a different color and having double-cushioned seats, and we guarantee each passenger a seat. Those lines, if the route is selected to tap a section that will respond to such a type of service, are doing very well indeed. I think there is considerably more room for them in our territory.

The State law in New Jersey requires a definite route for motorcoach operation and would not allow us to operate a coach as a taxicab, to carry passengers wherever they wanted to go, in regular service. I believe there is a very definite field for a smaller vehicle than the present standard city-type motorcoach which seats 29 to 33 passengers according to different types of body, and I have told several manufacturers so. They would have to be placed in carefully selected locations, where the length of the run would be short. On a short run success depends on frequency of service rather than on capacity of the vehicle.

This taxicab business is a disturbing factor from the point of view of a local transportation organization. I do not know how it is to be curbed, whether by legislation, restricted licensing on the part of the municipalities, or a combination of the two perhaps.

CHANCE TO BUILD GOOD-WILL

H. G. MCCOMB[7]:—One word, "Salesmanship," used by Mr. Crawford caught my attention. I think the lack of the thought implied by that has put the transportation business on our streets in the general bad favor in which it is today. The street-car, I fear, built up enmities all over our Country primarily because it was noisy; then, because the operating companies did not think of the little things that we all appreciate so much when we are buying something. For example, we held on to a strap which let us sway like a quarter of beef on a packing-house conveyor. Then some of our subway lines installed enameled loops which squeezed our fingers and let us sway in one direction at least. Seats were uncomfortable and we found very often that the motormen and conductors were selected from a class of persons that we certainly would not deal with in a department store.

In our other commercial relations, notably when we go into a department store, we find a spirit of courtesy and thoughtfulness for the customer throughout the establishment. I think we have in this motorcoach industry a really excellent opportunity not only to haul passengers but to build up their good-will.

Lately I have seen a notable case of a street-railway company having bought a number of motorcoaches that must be a nightmare to persons living along the routes simply because of the poor mufflers. One would think that no industry today that is trying to make money would be indifferent to giving offense to the public.

[7] M.S.A.E.—New York City.

The ordinary motorcoach is rather badly ventilated; I have seen none in which provision was made for forced ventilation. If there are 30 persons in a coach, they have a right to a certain number of cubic feet of air per minute; let us give it to them, not by raising an occasional window, but by putting in a pump and forcing in the air.

We are very often annoyed in a motorcoach by the fumes of the exhaust. It does not reflect much credit upon us as engineers to say that we cannot pipe out the chimney fumes without having them leak into the room where the customers are.

In the summer we look forward with dread, I think in many cases, to a motorcoach ride. When inquiring into this subject a little, I went to the Society of Heating and Ventilating Engineers and asked as to the relative heat-absorption of roofs with various colors of paint. There I was put in touch with a man who is working in the Bureau of Mines for that Society and had done considerable experimental work on this subject. He said, "If you paint the roof white, the motorcoach will absorb 40 per cent less heat from the sun's rays." But I do not recall ever having seen a motorcoach with a white roof.

These things may seem like small details. Operators perhaps will say, "We are too busy hauling passengers to think about pumping in air for them, and about the kind of the straps to give them a rigid support from which to hang, shaped to fit the hand instead of squeezing the fingers." But if the industry wants to take advantage of this great opportunity it has today, to build up a good-will which in the years to come will be worth untold millions of dollars, it seems to me that this is the time to start, in the inception of the industry.

I was astounded when reading about the American Electric Railway Association convention in Cleveland, to learn that someone had finally, after all these years, put on the streets of Cleveland a noiseless street-car; it reminded me of times when I have gone to a city where a street-car line had a crossover in front of the hotel and asked the room clerk to give me a room away from the street-car line, for one could hear the noise of the collision of wheels with rails for blocks. That, it seems to me, is not good engineering, because good engineering is quiet engineering.

The American Posture League is willing to tell anyone how to make a seat that is comfortable, yet we find ever so many seats that are merely padded or stuffed, like a club chair, and which are not comfortable.

These things have a real commercial application. I have noticed it by comparision with the motion-picture theaters. In the earlier days the pictures were interesting and the spectators herded in to see them. Soon they stopped being so eager to go. Then some of the smartest merchandisers, men like Roxy in New York City, built picture houses. They said, "We are going to make people like to come here." They had found that the trade fell off in hot weather, so they got in touch with a Newark engineering company that advertised "manufactured weather." Now people go into Roxy's in the summer to keep cool, and they know that in a house of that kind a certain number of cubic feet of air is being pumped in per minute.

If we merely look into other organizations that are making a great deal of money today, we shall be forced to realize that the mere hauling of a man is a very

small act to perform; the real thing we must do is to build up his good-will by making him feel that we are giving him smart service in every little detail. Thus we shall put the motorcoach industry on a basis for sure, safe and sound progress.

Tires Undersized and Overloaded

WILLIAM G. KEARNEY[8]:—I want to leave one or two thoughts on the subject of long and short-haul transportation as the tire manufacturer sees it. Unquestionably, high-pressure tires will be used on the short haul and in city service, because they give a lower center of gravity and are capable of carrying greater loads with a smaller cross-section and outside wheel-diameter. Furthermore, on a short haul the riding-quality of the vehicle is not a question of great importance.

It has been very interesting this year to note tire operations on long-distance runs from Detroit to Pittsburgh and from Pittsburgh to Buffalo. The coaches are able to maintain higher speeds, are more comfortable and give greater economy on balloon tires. However, the main factor, as we see it today, is the fitting of the vehicle with the proper size of tires to carry recommended loads and the maintaining of correct air-pressures en route.

The tire companies find that vehicles are habitually undertired. This is almost entirely beyond our control. The manufacturer who makes the chassis tires the vehicle properly, but when the body is applied, instead of an 18,000-lb. load, the load usually is 24,000 lb. In 1927, 38 x 9.00-in. balloon tires were used on vehicles carrying a gross load of 18,000 lb. and usually gave good mileage. Furthermore, they gave excellent continuity of service. In 1928, motor-vehicles weighing 24,000 lb. are endeavoring to use 38 x 9.75 tires. These are overloaded even more than the 38 x 9.00 were on the 18,000-lb. vehicles. The proper sizing of tires on vehicles will always be an important factor in service rendered by either high-pressure or balloon tires.

CHAIRMAN SCHREIBER:—Did I understand you to say that you think the high-pressure tires will stay for both the city and the interurban service?

MR. KEARNEY:—I believe they will. It has been our experience that they give good continuity of service. They are able to maintain a lower center of gravity and to carry greater loads per inch of cross-section and of outside diameter.

CHAIRMAN SCHREIBER:—I think you will find considerable difference of opinion on that subject. Many operators believe the balloon tire has got to come on both the city-type and the interurban motorcoaches.

MR. KEARNEY:—It probably will come when the coaches can be designed and the tires specified to carry proper loads. At present, on certain double-deck coach operations, it is impossible to equip the coach and maintain a low center of gravity with sufficient wheel-pocket clearance and spacing for balloon tires. We have been conducting experiments with pneumatic tires on double-deck coaches; in fact, last year all these double-deck coaches were changed over from solid tires on the front wheels to high-pressure pneumatic tires. This year we have changed the rear tires to 40 x 8-in. size on several of the vehicles.

In cities like Pittsburgh, where the coaches operated in de luxe and express service are carrying rated loads, the mileage and continuity of service are better on balloon tires. Balloon tires give excellent results, especially on commercial vehicles, in that city.

[8] M.S.A.E.—Manager, mileage contracts and field service, B. F. Goodrich Co., Akron, Ohio.

Temperature Measurement and Control

IN recent years one industry after another has discarded with gratifying results "hit and miss" methods of measuring operating temperatures in favor of accurate scientific instruments. Many others are seriously considering doing so. Lack of scientific temperature control has been responsible for many troubles and a considerable monetary loss. Hardly a large furnace, whatever its source of heat, is now installed without being equipped with automatic temperature control and recording instruments in some form.

Automatic control in general may be (*a*) the inexpensive temperature regulator, (*b*) controlled valve electrically operated, (*c*) controlled valve operated by steam or water pressure, or (*d*) controlled valve operated by compressed air. The central temperature-control room is now a common sight in the industry. In this one sees a series of recorders on which the temperature of all furnaces at every hour in the day is automatically recorded before the eyes of the man in charge. He knows the exact temperature at which each furnace should operate and can tell by a glance at the proper recorder how well each furnace is holding its temperature.

In some installations each furnace is fitted with three lights, one white and two colored. When the white light burns, the temperature is correct. If, however, either of the colored lights burns, the temperature is too low or too high. During the last ten years optical pyrometry has become important. This is temperature measurement by comparing the color of an incandescent furnace-interior with the color of an electrically-heated incandescent filament. It is, however, limited in scope and is in no way related to automatic control.

Many ingenious devices have come into use within very recent years for controlling the heat-treatment of steel by virtue of certain changes in state within its transformation range. These include the hump furnace, which automatically registers the momentary arrest in its temperature rise; the dilatometer, which registers arrest in expansion; various devices which automatically show the loss in magnetism that occurs when the transformation point is reached. The oil industry is another notable example of the value of scientific temperature-control. This is illustrated by the fact that a difference of 5 deg. fahr. in a certain cracking process may cause a difference of 7 per cent in the yield of gasoline—Industrial Bulletin of Arthur D. Little, Inc.

Problems of Motorcoach Design and Manufacture

By G. A. Green[1]

Metropolitan Section Meeting Paper — *Illustrated with* Charts

SLOW progress has been made in motorcoach design, in the opinion of the author, because of lack of foresight by the manufacturers and the largest potential users.

Three capacity-classes of motorcoaches are listed. A tendency toward increased weight is found to parallel a similar trend in motor-cars, and the public desires the same kind of performance in both types of passenger vehicle.

Present motorcoaches fall far short of motor-car performance, and engines for cross-country vehicles will be made much larger; but dimensional restrictions and cost make it almost impossible to secure motor-car performance. Twelve-cylinder V-type engines having equal bore and stroke are predicted as a possibility.

The argument of the paper is supported by curves comparing actual and possible performances of motor-cars and motorcoaches.

Definite suggestions are given for the direction of research on various motorcoach subjects, including superchargers, transmissions, steam power, oil-cooling and the six-wheel type.

However desirable any important changes may be, they will come slowly because of business reasons. Therefore the author holds that no prospective buyer is justified in fearing that present vehicles will soon become obsolete.

ABOUT 20 years ago, when horse-drawn stages were being operated for hire on Fifth Avenue, New York City, the first motorized equipment appeared there; but it would be wrong to say that, as regards design, progress during this period has been rapid, for it certainly has not been. The motorcoach industry is still in its swaddling clothes. The lack of progress unquestionably is due to lack of foresight. Neither the manufacturers nor the electric and the steam railroads, which are the largest potential buyers, were at first able to see the possibilities of the motorcoach. This condition has changed now, but valuable time has been lost needlessly.

While on the subject of progress, it should be mentioned that there are some very interesting recent developments; namely, the Fageol Twin-Coach, the Versare gasoline-electric, the A. C. F. Metropolitan, and the Yellow eight-cylinder-engined Model W and improved Model Z. Mechanically, the construction of these vehicles may or may not be open to criticism; but, even assuming that criticism is justified, the net result represents a real contribution to the industry.

Types of Equipment in General Use

At present there is a clearly defined demand for at least three general motorcoach types, with a number of different body styles, the so-called street-car and parlor-car bodies being fitted to any of the chassis. Very briefly, these chassis types are:

(1) A small vehicle particularly suitable for school and hotel service. Both automobile and truck chassis, with relatively minor changes, are commonly employed for these uses, and the design needs no particular comment. Such vehicles accommodate from 8 to 16 passengers, and an automobile powerplant provides a satisfactory performance.

(2) A vehicle which might be described as a medium-duty motorcoach, with seats for 17 to 25 passengers. There is a growing demand for such vehicles, but this demand has been slowed down as a result of unsatisfactory design. This is because in the past these vehicles have been assembled largely from motor-truck parts. On the whole, these vehicles have been a disappointment to the user. The powerplants were too small, the general construction too light, and the maintenance costs very high, but these conditions are changing and satisfactory chassis are now available.

(3) A vehicle which might be described as a heavy-duty motorcoach, seating from 25 to 40 passengers. This class of vehicle in the smaller seat-capacities is in general use throughout the Country by public utilities and others, for both urban and interurban services, including long-distance day-and-night and coast-to-coast runs.

The 40-seat-capacity type is of somewhat recent development and may be described as a mass-transportation unit. The entry of this vehicle into the field has aroused a very considerable interest.

For urban operation the present types seem to give fairly satisfactory results, although added power would be welcome in the larger units; but in interurban service, particularly on the long-distance high-speed runs, the performance is in general decidedly poor because all such vehicles are underpowered. Such vehicles do not meet with public approval, as they lack that which the public desires most; namely, automobile performance with respect to speed and acceleration. These comments are intended as general and should not be applied to any specific type.

[1] M.S.A.E.—Vice-president, in charge of engineering, General Motors Truck Corp., Pontiac, Mich.

Motorcoach manufacturers who desire adequately to cover this field require more than one size of powerplant, because the very large power-output so necessary for the heavy-duty parlor-car would, in the majority of cases, be unsuitable if used elsewhere. It is apparent that smaller engines can be employed for urban than for interurban operations, because a lower gear-ratio can be used with the former.

In considering my views on powerplant problems, it should be understood that my criticism is directed chiefly against vehicles in class (3) for long-distance high-speed runs. In analyzing this issue I shall use the automobile as a basis of comparison, believing that the American public desires automobile performance. Therefore this performance will be described in simple language and compared with the performance of the motorcoach. Some of the difficulties that confront us in obtaining such performance will be shown also.

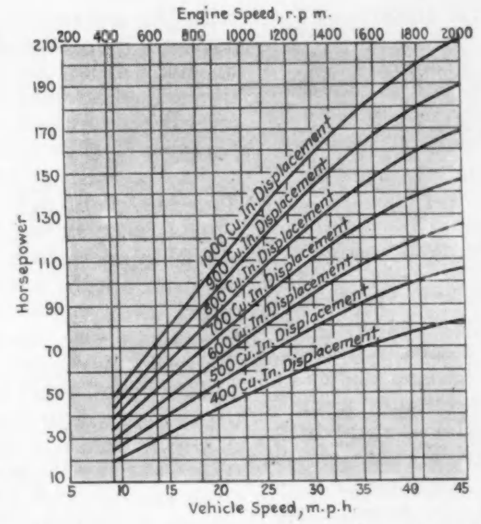


FIG. 1—POWER CURVES OF ENGINES OF VARIOUS SIZES

These Curves Are Based on the Mean Effective Pressure of the Yellow Model-Y Engine

MOTORCOACH WEIGHTS INCREASING

Our tremendous weight additions result in part from increased seating capacity, but a large percentage of the added weight is due to the natural desire of the operators for improved safety, comfort, appearance, speed, acceleration and deceleration.

Another point bearing upon the weight question is that manufacturers must provide equipment which will perform satisfactorily under almost any operating conditions, including misuse, abuse and poor servicing. Furthermore, since the manufacturer invariably is judged by his failures and not by his successes, a very small failure-percentage has disastrous consequences. The natural result is a tendency to build oversize, and the manufacturer actually is obliged to do this as a protective measure.

The first motorcoaches were merely horseless carriages, with all of the discomforts implied. Most of the designs were based on current motor-truck practice. On looking back, it seems ridiculous that an attempt ever should have been made to provide vehicles of the same character for the haulage of both freight and passengers.

Today virtually everyone recognizes that all vehicles for passenger transportation are in the automobile class. Their only actual difference is in seating capacity. This, of course, is a very obvious issue now. The motorcoach and the automobile employ the same highway, and the public is demanding that motorcoaches compare favorably with the customary automobile as now built, in safety, comfort, appearance, speed, acceleration and deceleration.

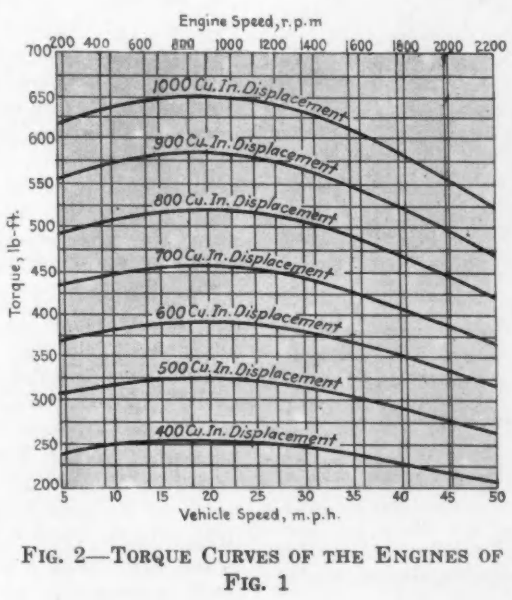


FIG. 2—TORQUE CURVES OF THE ENGINES OF FIG. 1

Unfortunately, however, the difficulties which have to be met in satisfying public demands as regards motorcoach performance are many and varied, of which perhaps the chief is the fact that there is no universal opinion as to what constitutes the most desirable form of motorcoach. Then, also, it must be remembered there are wide differences in the requirements and conditions of the various services, including speeds, loads, road surfaces and grades. This means that, unless a vehicle is specifically designed to meet the needs of a specific kind of service, compromises are inevitable.

But in a relatively new industry we can scarcely expect uniformity of opinion on the part of both the manufacturer and the user, and it is evident that the manufacturers hold widely divergent views as regards mechanical fundamentals. For example, the purchaser is offered powerplants of varying types, possessing in total from 4 to 12 cylinders. He may also acquire single or dual installations of both gear and gasoline-electric drives; and steam may become a competitor before long. The net result is a certain amount of confusion on the part of the buyer.

Americans are unmistakably automobile wise and it is difficult, if not impossible, to tell them that they cannot have the performance from their motorcoaches that they get from their automobiles, particularly taking into account the fact that many of them are willing to pay for this performance. Nevertheless, it is most difficult to provide this performance, and both the purchase price and the cost after purchase have a vital bearing on the issue. Furthermore, there are serious legal and technical difficulties which must be met.

At present the various States hold different views concerning permissible motorcoach width, length and height and in many instances legislation exists which conflicts one State with another.

The data presented in Table 1 on dimensional restrictions embodied in the motor-vehicle laws of the various States will make this point clear.

This condition imposes needless hardships, particularly the restrictions on width and length. The length restriction is possibly the most embarrassing. Parlor-cars 30 ft. long over-all, as a rule have seats for 29 passengers, but they are not comfortable seats because the spacing is altogether too close. A relatively small addition to the length

TABLE 1—RESTRICTIONS ON MOTORCOACH DIMENSIONS

Maximum Length, Ft.	States	Maximum Width, In.	States	Maximum Height, Ft.	States
28	2	84	1	12	4
30	9	90	7	12 1/6	1
33	6	92	1	12½	12
35	2	93	1	14½	6
40	3	96	31	None	26
None	27	102	1		
		None	7		

would make a great difference in comfort, yet this is not permissible in 11 important States. As a result, the majority of these vehicles are held within a 30-ft. over-all limit. It would be possible to develop bodies of varying over-all lengths, but the introduction of a number of models means increased production costs, which are undesirable to both the buyer and the seller.

It is quite possible to increase the seat spacing by simply removing seats; but, as any change necessitates the elimination of four passenger-seats, such procedure is not welcomed by the operator. In fact, from the viewpoint of revenue-loss, very often this would be impossible. The net result is that virtually all urban and interurban equipment is provided with insufficient seat-spacing, with resultant passenger discomfort.

Reference has been made already to the tendency toward a very considerable increase in motorcoach weight. To a less extent, a similar condition has arisen with the automobile. This, together with the fact that automobile owners demand a high-gear performance of no mean order, has necessitated a constant increase in the size of automobile engines. Furthermore, the owners expect to cover the major part of their journeys in high-gear. The inconvenience of gearshifting does not appeal to them at all; neither does the resultant noise. This last point will be referred to later.

The increase in the size of automobile engines now almost represents an annual change, but this condition does not obtain with the motorcoach. Most of the so-called large motorcoach-engines were designed four to five years ago, and their displacements remain unchanged. Improvements have been made which result in added power, but these increases are insufficient to meet the actual requirements.

What permits automobile manufacturers to make constant powerplant changes is the fact that they can spread their development and tooling costs over a very large volume, a condition that does not exist in the motorcocah industry. In this connection it is interesting to note that recently a well-known automobile manufacturer increased the displacement of two of his engines approximately 18 per cent. To do this required engines that were, to all intents and purposes, new engines, although few if any modifications were made other than in the size of the parts. A layman could scarcely distinguish the new engines from the old, yet the cost of the development and tooling was more than $5,000,000.

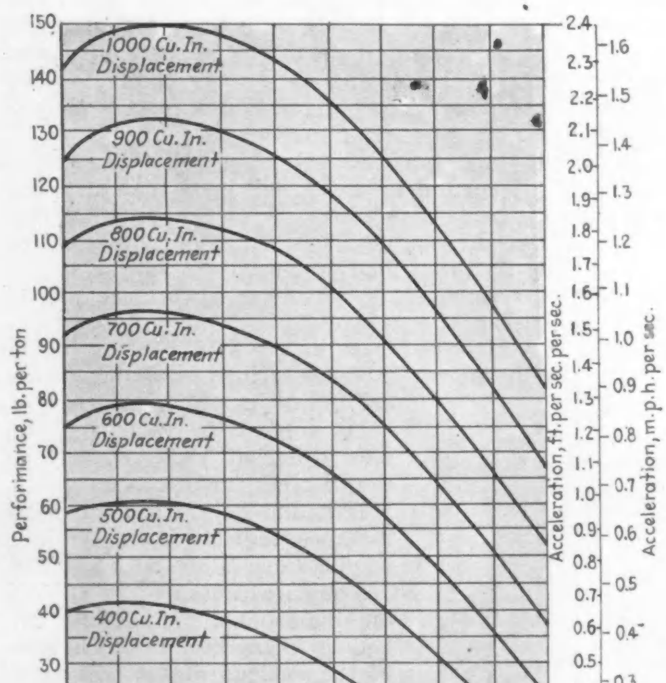


FIG. 3—PERFORMANCE CURVES OF ENGINES

Based on 85 Per Cent Efficiency, 5.2-1 Axle Reduction, 40-In. Wheels and a 19,250-Lb. Vehicle. Scales Are Given for Performance, in Pounds per Ton; Acceleration per Second, in Miles per Hour and Feet per Second; and Gradients Climbed in Per Cent

A Comparison of Performances

In a general way we know quite well that there is a vast difference between automobile and motorcoach performance. This is to be expected in view of the fact that the commonly so-called heavy-duty motorcoach engines displace only 450 to 500 cu. in.

To be specific, let us consider the actual high-gear acceleration, in terms of miles per hour per second from 10 to 35 m.p.h., of this year's automobiles and motorcoaches, under load. It will be found that the average high-gear acceleration value for the automobile is 2.262 m.p.h. per sec., and the maximum is 2.53. The corresponding motorcoach figures with a full passenger-load, considering both urban and interurban equipment having various seating-capacities, are 0.50 and 1.25 m.p.h. per sec. It should be mentioned that the last is an unusually good performance, as judged by present standards for motorcoaches. To the best of my knowledge, only one model of motorcoach will give such a performance. This is the Yellow Model-W parlor-car, which has, in round numbers, a 100-hp. engine for a 17-passenger vehicle weighing 10,000 lb. without load. It is clear that, comparing motorcoach and automobile performance, the advantage is in favor of the automobile in terms of from 2-1 to 5-1.

To present clearly the motorcoach performance that can be expected as a result of the employment of engines of widely varying displacements, a series of graphs has been prepared, from certain assumptions as to rear-axle ratio, tire size, wind resistance, rolling resistance, efficiency and weight. The mean effective pressures of the Yellow Coach Y engine were used in arriving at the horsepower and torque figures. The data can be considered as applying specifically to interurban high-speed equipment. The weight, 19,250 lb., is not abnormal, since it includes a full complement of both passengers and baggage.

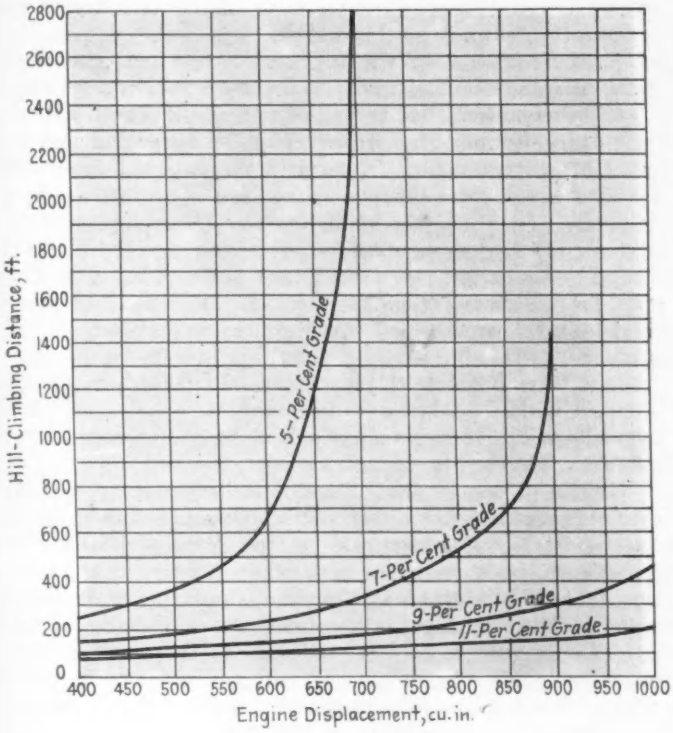


FIG. 4—HILL-CLIMBING DISTANCE

This Chart Shows the Distance a Vehicle Will Climb Starting on a Given Grade at a Speed of 20 M.P.H. Before Slowing to 5 M.P.H. The Data Are the Same as for Fig. 3, with 1¼ Per Cent Rolling-Resistance and 48 Sq. Ft. for Wind-Resistance

The calculations are based on: (*a*) no change in the efficiency of the powerplant or drive mechanism resulting from change in engine size; (*b*) a uniform vehicle-weight, irrespective of engine displacement; and (*c*) the same relative power-consumption for all accessories.

Engines of Different Sizes Compared

In Fig. 1 are shown horsepower curves of engines displacing from 400 to 1000 cu. in., with engine speeds and corresponding vehicle-speeds. It will be seen that the maximum power-output is available at 2000 r.p.m., which is equivalent to a road speed of 46 m.p.h. The 400-cu. in. engine produces a maximum of 82.5 hp., and the 1000-cu. in. engine, 212 hp. The corresponding torque is shown in Fig. 2. The maximum torque is available at 800 r.p.m., which is equivalent to a road speed of 18 m.p.h. The curves are fairly flat between 400 and 1400 r.p.m. With the 400-cu. in. engine the maximum torque is 256 lb-ft. With the 1000-cu. in. engine the corresponding figure is 650 lb-ft.

The performance in pounds per ton; the acceleration per second, in both miles per hour and feet per second; and the hill-climbing ability on various grades are charted in Fig. 3. Note that the maximum acceleration with a 1000-cu. in. engine is 1.63 m.p.h. per sec., and that this is effective at a road speed of 15 m.p.h.

Fig. 4 is a graph showing engine displacements in relation to hill-climbing ability on grades of 5, 7, 9 and 11-per cent. These data are based on the vehicles approaching the bottom of the hill at a speed of 20 m.p.h., and the vehicles are considered as having stalled when they are slowed down to 5 m.p.h.

It is interesting to note that engines of the following displacements are required in order to climb these grades:

Grade, per cent	5	7	9	11
Engine Displacement, cu. in.	700	900	1,182	1,406

Actually, a 1000-cu. in. engine will stall on a 9-per cent grade after going 450 ft. and on an 11-per cent grade after going 200 ft. It has been stated previously that these calculations are all based on high-gear performance. Of course, stalling would not occur in actual practice, because the operators would shift gears in time to avoid this.

Fig. 5 shows acceleration values in miles per hour per second and in feet per second per second from 10 to 25 and 10 to 35 m.p.h. This graph is of special interest as it makes possible a ready comparison of the relative acceleration ability of the automobile and the motorcoach.

It has been shown previously that under laden conditions the average 1928-automobile acceleration-rate from 10 to 35 m.p.h. is 2.262 m.p.h. per sec., and the maximum is 2.53. To duplicate this condition with a motorcoach having characteristics as outlined in the graphs will require engines displacing 1425 and 1605 cu. in., respectively. Such engines would be capable of delivering, respectively, about 302 and 340 hp. This should be regarded only as a theoretical conclusion. In actual practice considerably more power would be needed than these figures indicate.

Technical and Practical Problems

Following are some of the problems that must be taken into account in connection with the employment of larger motorcoach-engines.

Effect of Increased Factory Costs on Selling Prices.—The designing and development, including samples, testing, patterns, tools, jigs and fixtures, would require an expenditure of at least $500,000 to produce what might be termed a heavy-duty engine. This estimate is based

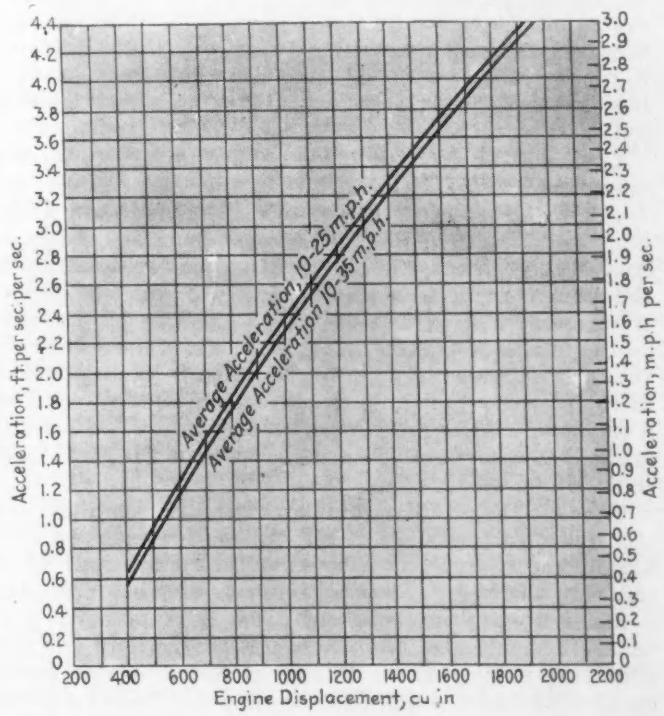


FIG. 5—RELATION BETWEEN ACCELERATION AND DISPLACEMENT BASED ON THE SAME DATA AS FIG. 3

on limited tooling, suitable for about 2000 units annually.

It is possible to employ heavy-duty motorcoach engines modified in various respects for marine purposes, rail-cars, tractors and the like, but this kind of business is highly specialized and, with the exception of the tractor, no great volume is in sight. Unfortunately, first cost is an all-important issue with the tractor and this practically rules out the possible use of the motorcoach engine. This shows the very limited production potentialities of the motorcoach engine.

Effect of Additional Weight on Tires.—With larger engines the tire-mileage cost will be greater. Larger tires will be needed to carry properly the additional weight of both engine and chassis. Also, more rapid acceleration means increased tire-wear. Obviously, the larger the tire is the more difficult is the steering. Moreover, tire-diameter increases affect adversely the turning radius.

Effect of Additional Length on Passenger Space.—A larger engine will project farther into the body, with a resultant decrease in passenger capacity. This may be partially offset by permitting the engine to project behind the dash, but there is a limit to this.

With the existing so-called heavy-duty engines, an average parlor-car, the over-all length of which is held within 30 ft., cannot accommodate more than 29 passengers with any reasonable degree of comfort. Assuming an engine having a capacity of 700 cu. in. or more, even taking into account the maximum permissible projection behind the dash, the seating capacity in all probability would be reduced to 25 passengers unless the over-all coach-length were arbitrarily increased; and that, as stated before, would rule out this type of equipment from 11 important States.

Effect of Additional Torque on the Drive Mechanism.—The drive mechanism must be strengthened throughout, which means the enlargement of clutch, transmission, propeller-shaft and final drive. Naturally, considerable additional weight will result. In effect, a very large engine will necessitate what practically amounts to a new chassis, with resultant designing, testing, tooling and development expenditures of possibly another half million dollars.

Cooling.—The cooling problems are involved. With a single-engine installation, the frame determines the width of the radiator, the driver's vision and the ground clearance fix the height dimensions, thermal conditions control the thickness of the core, and power losses limit the amount of air that can be drawn through the core. At present, with some designs, as much as 10 per cent of the available engine-output is at times used to drive the fan. As an average, probably from $2\frac{1}{2}$ to 5 per cent of the power output is so employed continually. This is a factor of considerable importance, particularly considering that a corresponding percentage of the total fuel-bill is involved.

There is the alternative of providing two engines, but that presents a number of difficulties; for example, seat arrangement, cooling, preventing heat and odors from entering the body, accessibility, and—last but not least—added upkeep-cost resulting from the dual-drive system. It should also be pointed out that, where two engines are employed, the cooling problems are as great as, if not greater than, with the single unit; and a point not to be lost sight of is that two relatively large engines will be needed, and the difficulties to be encountered from their projection both above and below the frame line cannot be discounted.

Fuel Economy.—With any very large increase in engine displacement a greater average fuel-consumption is to be expected; but the extent of the increase will depend largely upon the character of the operation and the skill of the operator. Naturally there is a loss in efficiency when very large engines are operated at part-throttle. On the other hand, the natural tendency of the driver will be to use all of the available power all of the time. Somewhere between these paths the right road will be found, but the ability to find this road involves a considerable amount of intelligence on the part of the driver.

If it were possible to increase considerably the engine output without adding weight to the engine or other chassis parts, the situation would be less serious; but, unfortunately, this cannot be accomplished.

Increased power should result in fewer accidents because the additional power will make it possible to maintain a higher average rate of speed without the wild bursts of speed that are now often indulged in. Also, the increased riding-comfort should attract patronage, with higher earnings as a consequence. Finally, schedule speeds will be higher, with a resultant lower platform-rate, but it is difficult if not impossible to forecast to what extent the advantages will cancel the disadvantages from the standpoint of the profit-and-loss account.

No accurate forecast can be made now as to the effect of larger engines upon operating costs in general. However, one point stands out with unmistakable clarity; namely, it is highly improbable that the performance of an internal-combustion-engined motorcoach can be expected ever to parallel that of the average automobile.

Engine Design Characteristics

Having reached the conclusion that larger engines are needed, the next step is to determine their general design characteristics. Engines must be available which will make possible sustained high vehicle-speeds. There are many services in which sustained speeds in excess of 60 m.p.h. are absolutely safe. But at such speeds engines should be capable of giving reliable service day after day, year after year, with only the absolute minimum of attention. Such vehicles will regularly cover from 75,000 to 100,000 miles annually and, assuming proper design, virtually no attention should be required other than a thorough examination and cleaning once a year, with repairs and renewals of minor parts. Furthermore, such engines should have an almost unlimited useful life.

It is needless to stress the reliability factor, particularly in connection with long-distance operation. In this service vehicles frequently do not return to their home divisions for weeks at a time; and, considering the great annual mileages, it will be seen readily that the actual time available for inspection and repairs is, as a rule, very limited. Failures of any kind are to be deplored, but the results of a failure of a motorcoach on a long-distance run are of immeasurably greater consequence than in city service.

A very important point is that six-cylinder engines of more than 500-cu. in. capacity cannot be expected to give economical service if operated for very long periods at speeds higher than 2000 r.p.m. The net result is that the size and weight of six-cylinder engines become out of all proportion where a very large power-output

is required. It seems reasonably clear that engines displacing more than 600 or 700 cu. in. should be of the V type, not the least of the advantages being the smaller space requirement. It also seems clear that, unless supercharging becomes a factor, the future heavy-duty parlor-car engine will displace from 900 to 1000 cu. in.

Generally, the length of large engines is determined by the bearings and not by the cylinder bore. For this reason, among others, a "square" engine should be considered and, since for a 1000-cu. in. engine a six would require a bore and stroke of 6 in. each, an eight of $5\frac{1}{2}$ in., and a twelve of $4\frac{3}{4}$ in., the evidence points to the largest number of cylinders; namely, twelve.

Research and Development Program

The Supercharger.—Supercharging is unquestionably a matter deserving of the closest possible scrutiny. Many passenger-car engineers disregard this issue altogether, preferring the popular annual reaming process. This is the easiest way out, but there is a limit to the possible size of motorcoach-engine cylinders, and engines of more than 700 cu. in. represent a tremendous mass of metal, take up a great deal of room and cost much money to buy and to maintain.

Tests made to date indicate that supercharging is within the realms of possibility. The best scheme seems to be the high-pressure-type blower of large size operated at relatively low speed. Unfortunately, there is little or no likelihood of developing superchargers that can be attached to existing engines, for the engine and the supercharger design must be worked out jointly. This, of course, means delay so far as production possibilities are concerned.

Transmission Improvement or Elimination.—Transmission design has changed very little since the first automobile was built—a rather discouraging state of affairs—and, no matter how one may reflect on the situation, it is little short of amazing that such a barbarous piece of mechanism exists in this day and age. The problem of gearshifting, therefore, is still with us. But the question of noise is the vital issue. There is no such thing as a quiet transmission, silence being used, in this connection, as a merely relative term. We all know that quietness is essential, yet we have no satisfactory means of measuring whatever success we may think we have attained, and, worse still, the fundamentals which would make possible the effective control of transmission noise are unknown.

The amazing developments that have taken place in automobile design, excepting only in the transmission, are appreciated by all. Unfortunately, however, only a very small percentage of the brains employed on this work are devoted to the transmission. Its deficiencies are recognized, but the only real cure found to date is to enlarge the engine. Hence the customary annual reaming process to which reference has already been made. Actually, automobile engines now have reached such sizes that transmissions can be regarded as auxiliary devices, their primary use being the reversing of the motion of the vehicle. But a different condition is faced with the motorcoach. No matter how we enlarge the engines, the transmission will be required to perform a considerable amount of service, and the higher torque which must be transmitted through future motorcoach transmissions will increase rather than decrease our difficulties.

From these remarks it should not be concluded that manufacturers are entirely asleep at the switch. Experiments are being made constantly in connection with various forms of variable gearing. Then there are the possibilities of electricity and, last but not least, of steam.

The Gas-Electric.—Concerning the gearshift and noise problems, it is considered by some that the gasoline-electric vehicle will be the final solution. Perhaps this is so, but the present electrical systems are heavy and expensive. The approximate weight of single or dual gasoline-electric equipment for use with an engine developing about 100 hp. is from 1900 to 2100 lb. The cost is in the neighborhood of $1 per lb. These figures speak for themselves.

It is evident that the manufacturers of electrical equipment for street and electric railways realize that this kind of business is diminishing. They also see the necessity for filling the gap in their production. But to date there is no visible evidence that their research laboratories are sufficiently active in planning to meet the very different conditions that exist in the motorcoach as compared with the street-car. Motorcoach manufacturers are offered today substantially the same kind of equipment that has been used in the electric-railway industry for a long time past.

It is recognized generally that the characteristics of the average motorcoach engine are not suited to the electrical equipment now available, and it has been suggested that the motorcoach industry should produce entirely special engines; but the enormous development cost is prohibitive. The average motorcoach manufacturer is reluctant to place himself unqualifiedly behind the gasoline-electric drive because he is not sure that the electrical manufacturers will move with the times.

Mention should be made of the fact that the gas-electric motorcoaches now built by the several American manufacturers are, generally speaking, mechanically sound. The only real objections are that the fuel-consumption, weight and cost are high.

Steam Propulsion.—It is somewhat surprising that steam has not played a more prominent part in the motorcoach industry. Perhaps here again the chief reason is that only a very limited percentage of the total available brains has been engaged upon the solution of the various difficulties. At first sight, steam is the ideal solution; however, little or no success has attended the several developments that have appeared. Nearly all steam-propelled vehicles give spectacular performance, yet none of them has withstood satisfactorily the acid test of time and distance. This does not mean, however, that steam is out of the picture; on the contrary, future developments along this line are assured. How successful they will be is hard to foretell; but the tremendous advantages, such as maximum torque at zero speed and absolute silence, are irresistibly attractive. Nevertheless, steam as a factor in the motorcoach industry is still far distant, and in all probability the great advantages have offsetting disadvantages; at least this has been the history in the past. So, until years of actual operating experience are available, it will probably be simply a question of exchanging one form of trouble for another.

Oil-Cooling.—Oil-coolers give the following potential advantages: (*a*) easier starting, since lighter oils can be employed; (*b*) less oil-consumption, as the viscosity can be kept more nearly constant; (*c*) less cost, because

more miles per gallon can be expected from relatively lower-priced oils; (*d*) less wear, because of better lubrication throughout resulting from a higher average-viscosity; (*e*) longer bearing-life, due to the decreased tendency for the babbit to soften from heat; and (*f*) less carbon formation, because the lighter oils have a lower carbon-content.

The modern high-speed interurban motorcoach is required to operate for very long periods, with the engine delivering a large percentage of its total power-output. This condition introduces a number of complications, particularly with respect to lubrication. As a result of the accumulated heat, many of the oils commonly used tend to decrease rapidly in viscosity, in some instances to such an extent that the oil film is no longer capable of supporting the pressure imposed upon it in the bearings.

In practically all aircraft engines provision is made for oil-cooling. It would be difficult, if not impossible, to run these engines successfully otherwise. The operating conditions of motorcoach and aircraft engines are in some respects parallel; high duty for continuous periods is one of the controlling issues in both cases. From the standpoint of decreasing engine operating expenses generally, the influence of oil-cooling cannot be over-estimated.

The Six-Wheel System.—That the six-wheel system will play an important part in the future development of the heavy-duty motorcoach there cannot be a shadow of doubt, notwithstanding the unsatisfactory service received from the earlier American models. We should not be misled by the popularity of this system abroad, since its acceptance there seems to be based largely on the known fact that such vehicles can negotiate bad ground with greater ease than can the conventional arrangement. In Europe the necessity for having available large numbers of vehicles which can fulfill this condition must always be borne in mind, particularly with respect to the various war departments' requirements, their vehicular standardization programs, subsidies, grants, and the like.

Much loose talk has been indulged in concerning the six-wheel system with respect to tire economy, riding properties and roadway damage. With present six-wheel designs there is considerable doubt in my mind of the tire economy; and, so far as riding properties are concerned, it can be readily demonstrated that just as good, if not better, results are obtainable with the conventional system. But the advantages are clearly in favor of the six-wheel system as regards possible roadway damage. While these advantages are most obvious with solid tires, we fortunately seem to be nearing the end of this abomination, and in the case of the high-speed heavy-duty motorcoach, which can operate to advantage only on relatively smooth, hard roads, this phase is not of prime importance, particularly taking into account the low-pressure tire, the use of which is rapidly becoming the rule rather than the exception.

The six-wheel system can be made to ride better than the conventional arrangement, and better tire-mileage can be expected; but there is another vital issue. With the six-wheel principle properly executed, so-called mass-transportation equipment for urban or interurban service can be designed with a relatively short wheelbase without excessive rear or front overhang. The importance of this cannot be over-emphasized.

The Shifting of Passenger Travel

The amazing growth of the motorcoach industry will be appreciated if consideration is given to the fact that, during the calendar year of 1927, this class of equipment handled 13.5 per cent of all passengers transported by all forms of common carrier. The development and expansion of the motorcoach industry during this period cannot fail to make one optimistic concerning the future. To grasp intelligently the significance of what has actually happened during the five-year period ended Dec. 31, 1927, it is of interest to reflect upon the relative use of various available means of passenger travel as shown by the following figures:

			Per Cent
Population	Increased		8.6
Common-Carrier Passengers	Increased		9.1
Riding Habit	Increased		0.4
Steam-Road Passengers	Decreased	92,826,473	9.7
Electric-Railway Passengers	Decreased	400,044,561	0.2
Motorcoach Passengers	Increased	1,657,000,000	197.0

It is interesting and at the same time somewhat humiliating to reflect upon the fact that the wonderful motorcoach industry has been built up almost entirely as a result of the vision, foresight and courage of the individual operators who until recently received little if any support from the manufacturers or the steam and the electric railroads. Undoubtedly, many will recall the pressure brought to bear upon the manufacturers by the individual operators to produce suitable equipment; also, that the manufacturers were for a long time deaf to the operators' pleas. This forced the individual operator to employ converted trucks and modified automobiles.

From an engineering viewpoint we should not be satisfied with the results already obtained. These comments apply with special force to the long-distance high-speed interurban type of coach. My feeling is that the engineers should leave no stone unturned to sell their respective managements upon the necessity for expending substantial sums on motorcoach research and development work generally, with particular reference to: larger engines; oil-cooling; the supercharger; the improvement or, better still, the elimination, of the transmission; the gasoline-electric drive; steam propulsion; and the six-wheel system.

It is perhaps needless to state that the efforts of all are required in connection with the modification of restrictive motorcoach dimensional legislation. This will necessitate an extensive educational program. Success can result only from enlightened public opinion.

Major Changes Will Come Slowly

It may perhaps be felt that some of my remarks are discourteous; but no discourtesy is intended. It seems to me that once in a while we should face the facts; and the facts as I see them are that we all have much ground to cover before we can boast of our achievements respecting high-speed long-distance equipment. You may say this is a poor sales-argument. I do not think so, my feeling being that most operators will be glad to know that manufacturers do not think that they know it all. I think operators will be glad also to know that manufacturers are continually experimenting with new devices of one kind or another. Then the fact that someone has sufficient courage to face openly the definite trend in public opinion toward a motorcoach with

(*Concluded on p.* 183)

Diesel Engines for Aircraft

By L. M. Woolson[1]

Chicago Aeronautic Meeting Paper — *Illustrated with* Charts and Drawings

ALTHOUGH the author and his associates have designed, built and tested a Diesel airplane-engine, a description of the mechanical details is omitted because the engine is still in the experimental stage. The general subject of Diesel engines for aircraft is therefore presented in its broader aspects.

Typical indicator-diagrams of a gasoline engine and of a Deisel engine are compared as a means of ascertaining whether the pessimistic attitude that the Diesel engine cannot be made light enough for aircraft-propulsion purposes is justified. These considerations lead to the statement that, since a practicable Diesel aircraft-engine must run at speeds five or six times as fast as the stationary or marine-type of Diesel powerplants, whereas the ignition time-lag is substantially the same, it can be seen that the high-speed engine demands a different type of combustion than does the low-speed Diesel.

Following considerations relating to large low-speed Diesel engines and the differences between low-speed and high-speed characteristics, the author discusses the very high cylinder-pressures that become necessary, which may be a maximum of 1200 lb. per sq. in. Such pressures may be thought to militate against sufficiently light engine-construction, but this fear is unfounded, he asserts, as is proved by the fact that the Packard Diesel aircraft-engine weighs less than 3 lb. per hp. and has been subjected to both flight testing and ground testing. Its capability of withstanding cylinder pressures well in excess of 1200 lb. per sq. in. has been accomplished without having recourse to excessively heavy construction.

Diesel aircraft-engine advantages are listed, an important one being the virtual elimination of the fire hazard; and the subject of economical fuel consumption is treated. Mention is made that the Diesel aircraft-engine interferes less with radio operation than does the Otto-cycle engine, because it has no electric-ignition system, and that the use of compression ignition increases safety.

In conclusion, the probable effects of the Diesel engine on airplane design are forecast, and the reliability of the Diesel engine is compared with that of the gasoline engine, to the advantage of the former.

DIESEL engines for aircraft has been the subject for many contributions to technical literature in the past. Theoretical discussions of considerable merit by British and German authorities have been published for many years and, more recently, our store of knowledge in this Country has been largely increased by the findings of the National Advisory Committee for Aeronautics in its laboratory experimental work at Langley Field, Va. In view of the existence of these voluminous data uncovered by such authorities as Clerk, Pye and Chorlton in England, Dorner and Neumann in Germany, Narita in Japan, Attendu in Canada, and Sperry, Treiber, Joachim and Beardsley in the United States, it would be futile for me to attempt to cover the same ground. It is therefore proposed to attack the subject from a somewhat different angle, and it seems advisable to outline the scope of this paper at the outset. It is proper to state here that Dr. Dorner has been associated with us in this work.

Although we have designed, built and actually tested a Diesel airplane-engine for several hundred hours, the description of this engine in all its mechanical details is regarded as being outside of the scope of this paper, not only because the engine is still in the experimental stage and therefore subject to frequent design-changes, but also because the general subject of Diesel engines for aircraft, emphasized and broadened by actual practical experience in this field, is worthy of discussion at this time in some of its broader aspects, neglecting for the moment such mechanical details as have been evolved to accomplish the desired purpose.

Heretofore the subject of Diesel aircraft-engines has been treated as an idealistic topic in which certain practical achievements were visualized as a result of painstaking and far-reaching research. Necessarily, however, as in all problems of a scientific nature, certain assumptions have been made by the various investigators and, while such a broad statement may be subject to criticism, it nevertheless seems that there was a general foreboding of extraordinary difficulty in the task of making a Diesel engine sufficiently light for aircraft-propulsion purposes. Let us therefore examine more closely the underlying cause of this pessimistic attitude.

Gasoline and Diesel Engines Compared

A logical starting point for such an investigation is a comparison of typical indicator-diagrams of a gasoline or explosion engine and of a Diesel engine. These are shown in Fig. 1; but an explanatory digression is immediately necessary to account for the third diagram entitled "high-speed Diesel" as distinguished from the "low-speed Diesel."

The Diesel cycle has been employed for more than a quarter of a century in internal-combustion engines used for stationary power plants of various descriptions and for marine propulsion-service, and these engines have been designed to obtain the theoretical ideal shape of indicator diagram such as is shown in Fig. 1 as representing the performance of a low-speed Diesel engine. Such engines have been intended to develop

[1] M S.A.E.—Aeronautical and research engineer, Packard Motor Car Co., Detroit.

peak cylinder-pressures very little in excess of maximum compression-pressures, and these have been in the order of 550 lb. per sq. in. Such engines operate on a true constant-pressure cycle, the cylinder pressure being maintained approximately constant for a small portion of the period represented by the power stroke of the piston, the fuel injection starting slightly ahead of top dead-center and continuing for several degrees past top dead-center. This constant-pressure cycle is in direct contrast to the constant-volume cycle attributed to the conventional gasoline explosion-engine, in which a carbureted mixture is drawn into the cylinder on the suction stroke and fired by an electric spark somewhat ahead of top dead-center on the compression stroke, where the consequent expansion of the charge results in a rapid pressure-rise with the gases maintained at substantially constant volume.

It is perhaps not generally recognized that the Diesel engine operating on the constant-pressure cycle is limited by that very restriction to comparatively low-speed operation. All combustion phenomena that occur in internal-combustion-engine operation require a definite time for their completion. Just what is involved in this time-lag is by no means well understood by combustion engineers, but it is universally recognized that due time-allowance must be made for the consummation of the intricate physical changes and chemical transformations resulting from the ignition of the charge, whether brought about by the electric spark of the gasoline engine or by the highly heated air of the Diesel engine.

It is clearly obvious that any engine suitable for aircraft propulsion must be more or less of the high-speed type; that is, it is inconceivable that an engine running at a maximum speed of 200 or 300 r.p.m., as in ordinary Diesel stationary-powerplant practice, could ever be made sufficiently light for flight purposes. Even the veriest tyro in airplane-engine design will concede that an airplane engine must operate at speeds in excess of 1400 or 1500 r.p.m. if it is to begin to compete with existing aircraft powerplants. Still higher engine-speeds are desirable up to the point where propeller efficiency in the plane of moderate speed begins to fall off and makes still higher engine-speeds less desirable unless accompanied by reduction gearing, the advantage of which is questionable in many cases. Granting, then, that a practicable Diesel aircraft-engine must run at speeds five or six times as fast as the stationary or marine type of Diesel powerplants, whereas the ignition time-lag is substantially the same, it can be seen readily that the high-speed engine demands a different type of combustion than does the low-speed Diesel.

Large Low-Speed Diesel Engines

I am indebted to Lieut. John V. Huse, U. S. N., for some general information regarding large low-speed Diesels, and it may be of interest to consider briefly some of the characteristics which place them in a class entirely apart from the aircraft engines we are considering.

The engine with which I am experimenting has a bore of about 5 in. and a stroke of about 5½ in., whereas large low-speed Diesels will average, say, 26-in. bore and 40-in. stroke. The Fiat company has built one of the largest Diesel engines in the world, with a bore of 37 in. and a stroke of 38 in., this being of the double-acting two-cycle type and developing more than 2000 hp. in each cylinder. Diesel engines developing 12,000 to 15,000 hp. are used in German powerhouses and weigh as high as 400 lb. per hp. Diesel engines are, of course, used universally in submarines, with specific weights averaging from 60 to 100 lb. per hp. So-called Diesel engines of a great variety have been built in the smaller sizes for industrial purposes, and in most cases these are of the semi-Diesel, hot-bulb or ante-combustion-chamber type which do not generally have the high performance, good efficiency and high rate of revolutions demanded for aircraft use.

High and Low-Speed Characteristics

Continuing the discussion which is intended to bring out the difference in cycle operation between high and low-speed Diesels, the first thing we find is that fuel injection in the high-speed Diesel must start as early as 50 deg. before top dead-center to assure complete and smokeless combustion; whereas, in the low-speed Diesel, fuel injection usually starts about 10 deg. before top dead-center and continues until about 32 deg. past top dead-center.

In the case of the high-speed Diesel, when ignition starts considerably ahead of top dead-center, the cycle of operation does not differ materially from that of the gasoline or explosion engine, the spark of which is timed to occur at substantially the same point in the piston stroke that the fuel injection of the high-speed Diesel is timed to start. There is, however, the important difference that, when the spark occurs in the gasoline engine, all of the fuel charge is contained in the cylinder; whereas, when ignition starts in the high-speed Diesel engine, only a small percentage of the fuel charge has been injected. This latter condition enables the designer to control the pressure rise in the cylinder within certain limits, but in the case of a gasoline engine the pressure rise is obviously to a large extent beyond the designer's control, depending upon certain fixed factors the more important of which are the compression ratio, the state of turbulence and the temperature conditions within the cylinder.

Admitting that combustion in the high-speed Diesel engine must start considerably ahead of top dead-center and continue while the combustion space becomes reduced in volume more and more as the piston approaches top dead-center, it must be expected that cylinder pressures will rise more in accordance with the diagram obtained from the conventional explosion engine than in the manner attributed to the low-speed Diesel of true constant-pressure type. This accounts for the shape of the indicator diagram entitled "high-speed Diesel engine" in Fig. 1.

Since the high-speed compression-ignition solid-fuel-injection aircraft-engine referred to throughout this paper is termed a Diesel engine, an explanation is given to satisfy the criticisms of those who strenuously oppose the use of the term "Diesel" as applied to engines that do not operate on the true constant-pressure cycle. Authorities the world over have sought to differentiate between the Diesel cycle and the so-called dual or mixed-combustion cycle, or Sabathé cycle, in which the fuel is burned partly at constant volume and partly at constant pressure.

Although the distinction between the two cycles undoubtedly is an important one from a thermodynamic and also from a structural viewpoint, considering the

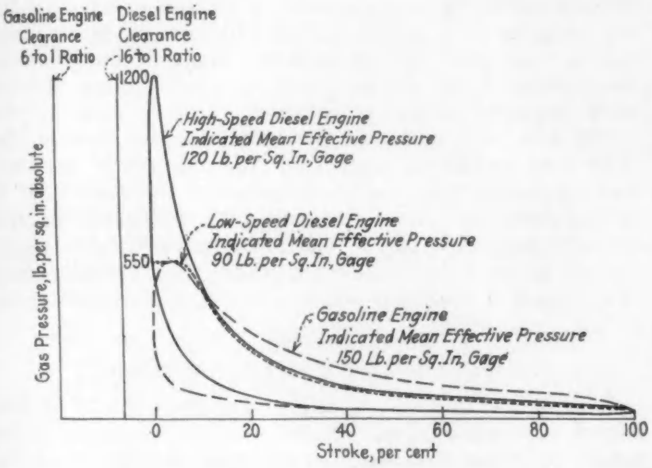


FIG. 1—TYPICAL INDICATOR DIAGRAMS

increased stresses brought about by the mixed cycle, still I consider that Dr. Diesel laid the groundwork for both types and that this achievement always should stand to his credit. The fact that at higher speeds combustion must proceed in a somewhat different manner than he originally contemplated does not seem to alter the case, since no basically new mechanisms have been added to his original engine to accomplish this result. It has been more a matter of great refinement in detail.

Incidentally, it is interesting to note that, as numerous authorities have pointed out, improved thermal efficiency results from the use of the mixed cycle rather than the original Diesel constant-pressure cycle; and this fact is perhaps best brought out in the paper by O. D. Treiber entitled, Modern Trend of the Diesel Engine with Respect to Low Weight per Horsepower, High Revolutions per Minute and High Mean Effective Pressure[2]. Fig. 2, reproduced from his paper, shows graphically the relations between both indicated mean effective pressures and thermal efficiency on the one hand, and various proportions of constant-volume and constant-pressure combustion on the other hand.

In a mathematical treatise[3] on this same subject, Toyoji Narita deduces that, when specific heat is regarded as constant, for the case under consideration the Diesel cycle would give an efficiency of 54.4 per cent and that the Sabathé cycle would give an efficiency as high as 56.7 per cent. The same calculations applied when specific heat is regarded as a lineal function of temperature results in the Diesel cycle giving an efficiency of 42.5 per cent, and the Sabathé cycle an efficiency of 45.3 per cent, thus proving that when combustion occurs partly at constant pressure and partly at constant volume the efficiency of the cycle is substantially improved.

The high efficiency of the mixed cycle has been proved also in a practical way by specific fuel-consumption readings as low as 0.35 lb. per b.hp.-hr. which have been obtained both by British experimenters and by Dr. Dorner and myself. It therefore appears that the mixed cycle, which I regard as indispensable in high-speed compression-ignition-engine operation, is preferable from both power and economy viewpoints to the straight constant-pressure Diesel cycle which is confined to low-speed-engine operation. Assuming, then, that both the necessity for and the desirability of the high-speed Diesel engine operating on the mixed cycle are agreed upon, we are ready to resume the discussion at the point where it was necessary to digress.

CYLINDER PRESSURES OF 1200 LB. PER SQ. IN.

We find that we are confronted with the problem of building an internal-combustion engine in which the maximum cylinder-pressures reach the high value of 1200 lb. per sq. in., as compared with the conventional maximum pressures of about 550 lb. per sq. in. obtained in the usual gasoline or explosion engine having a compression ratio of about 6 to 1.

Internal-combustion-engine designers who have been thinking for many years in terms of maximum cylinder-pressures of the order given are perhaps not to be blamed when they view with misgiving the task of building equally light engines to withstand maximum pressures about twice as high; yet, in other branches of engineering, there has been a constant march forward in the demand for higher pressures, temperatures or voltages as the case may be.

For example, according to statistical information supplied by the General Electric Co., the Chicago, Milwaukee & St. Paul Railroad is operating its electrified division on 3000 volts direct current, although for many years 550 volts has been considered a good standard. Or consider working boiler-pressures found in modern powerhouse installations; a few years ago 200 lb. per sq. in. was regarded as a satisfactory maximum, but today we find some installations using 1200 lb. per sq. in. and in others it is contemplated to use as high as 1400 lb. per sq. in. In Europe, steam locomotives are being operated with boiler pressures as high as 880 lb. per sq. in., and powerhouse installations carrying 3200 lb. per sq. in. boiler pressure are in actual operation. In hydro-electric installations, we find an example in this Country of an hydraulic pressure of 1100 lb. per sq. in., the head of water being 2500 ft., or about half a mile. In this case it has been necessary to make the penstock case 3 in. thick to withstand the pressure. And present alternating-cur-

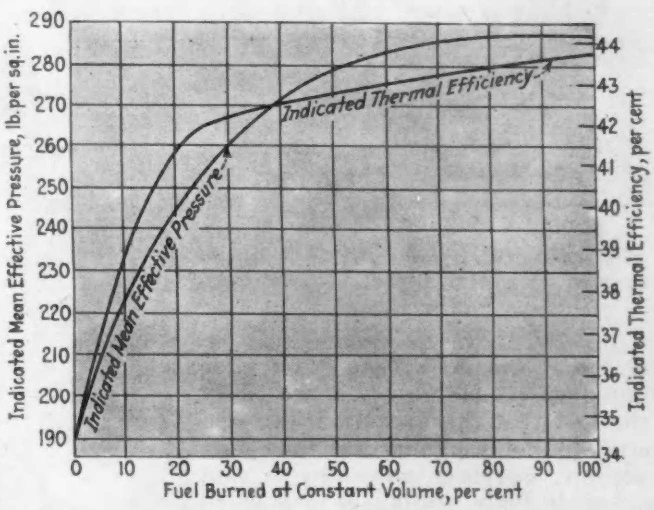


FIG. 2—EFFECT OF CONSTANT-VOLUME COMBUSTION ON ENGINE EFFICIENCY

[2] Paper read before the Society of Naval Architects and Marine Engineers, November, 1927.

[3] See *Journal of the Society of Mechanical Engineers*, Tokyo, Japan, vol. 28, pp. 323-333.

rent transmission lines are operated up to 22,000 volts or ten times what was regarded as fairly high voltage not many years ago.

These examples are cited to demonstrate that engineers in other branches of the mechanical and electrical professions have not been ultra-conservative in fixing safe maximum pressures, so why should we, who are operating in one of the youngest branches of engineering, namely, that of aircraft internal-combustion-engine design, hesitate at making similar advances?

Additional analogous inducements, if such be needed, for the aircraft-engine designer to develop Diesel aircraft-engines are furnished by reference to the impressive statistics covering the growth of the Diesel engine in marine service. At present there are under construction oil engines of more than 1,250,000 hp. for new motorships. In fact, very few new steamships are being constructed; statistics published by *The British Motorship* in August, 1928 show only 7 steamers with a tonnage above 8000 being built, but the number of motorships was 31. The figures apply to England. For the world at large the respective figures are 65 motorships and 21 steamers.

It should be pointed out that, in the final analysis. the demands on marine powerplants are very similar to those of aircraft. Both types of powerplant should be capable of running for long periods without stoppage. should be economical in fuel consumption, and should be sufficiently flexible to permit of maneuvering. In only one essential is there a considerable difference in the requirements; that is in relation to weight.

It has been assumed in many quarters that the high maximum cylinder-pressures encountered with the high-speed-Diesel principles militate against sufficiently light engine-construction to permit its usage for aircraft powerplants. That this fear is unfounded is perhaps best proved by the fact that the Packard Diesel aircraft-engine, weighing less than 3 lb. per hp., has been subjected to considerable flight testing as well as to several hundred hours of ground testing, and that a construction has been evolved which is fully capable of withstanding cylinder pressures well in excess of 1200 lb. per sq. in. without having recourse to excessively heavy construction. Departures from conventional aircraft-engine design were required in many instances; but, in general, the result has been achieved by utilizing materials of the kind best suited to cope with the respective stresses and by calculating the proportions of the structure so as to secure maximum strength with minimum weight. As a typical example, it has been necessary to forego the use of the light cast-alloys, where they are subjected to alternating stresses, because of the low impact-value of such material.

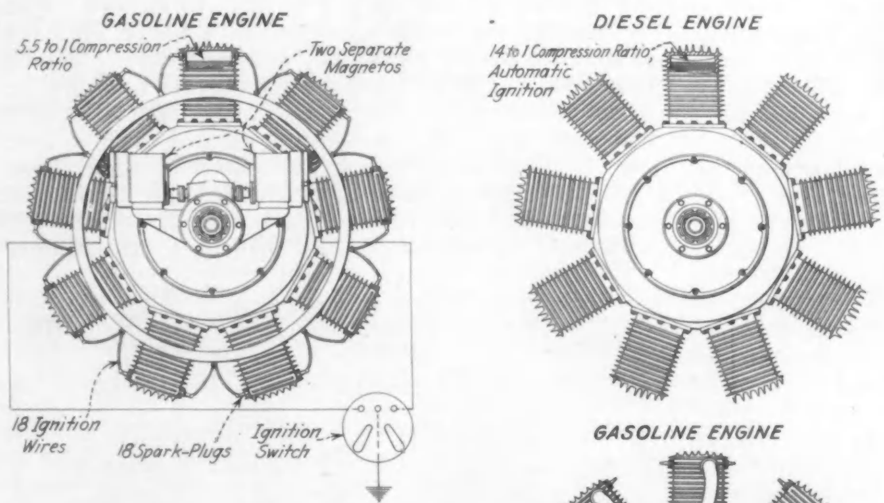


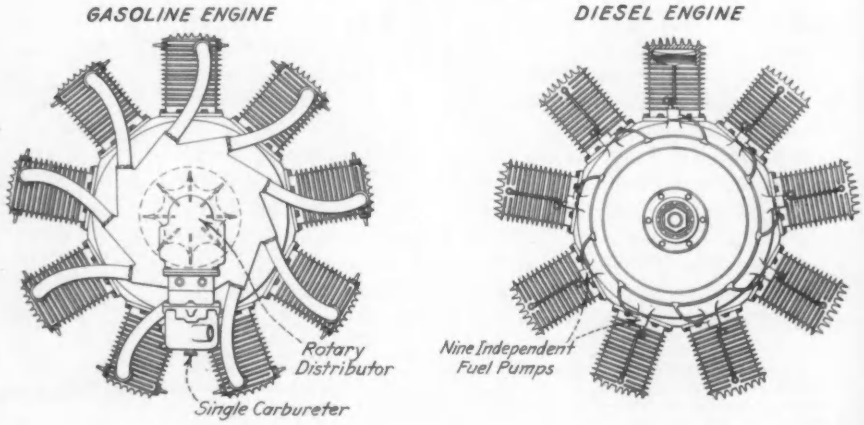
Fig. 3 (Above)—Comparison of Gasoline-Engine and Diesel-Engine Ignition-Systems

Diesel Aircraft-Engine Advantages

Passing on to some of the attractive aspects of the Diesel aircraft-engine, those of its characteristics which relate to reliability are perhaps of the most interest at present when safety and dependability are the two major requirements in the progress of aircraft-engine development. Compared with gasoline engines on the basis of reliability, the Diesel engine scores heavily in respect to the two most important accessories of internal-combustion engines; namely, ignition and carburetion, or fuel-injection systems.

Considering first the question of ignition reliability, Fig. 3 portrays the great simplification and the vast improvement in reliability resulting therefrom of the Diesel-engine ignition-system as compared with that of the gasoline engine. In the latter, considering a nine-cylinder radial engine such as is shown diagrammatically, two independent sources of ignition current are necessitated whether of the battery or the magneto type, two drives for these systems, 18 high-tension wires, 18 spark-plugs, and an ignition switch, comprising an aggregate of perhaps 1000 individual parts. The Diesel-engine ignition is furnished solely by the compression of the air charge and necessitates merely a smaller clearance-volume in the cylinder as compared with the gasoline engine. No additional parts of any kind are required, and continuous ignition is assured as long as the engine is operating, whether it be for 1 or for 1000

Fig. 4 (Below)—Comparison of Gasoline-Engine and Diesel-Engine Fuel-Feeding Systems



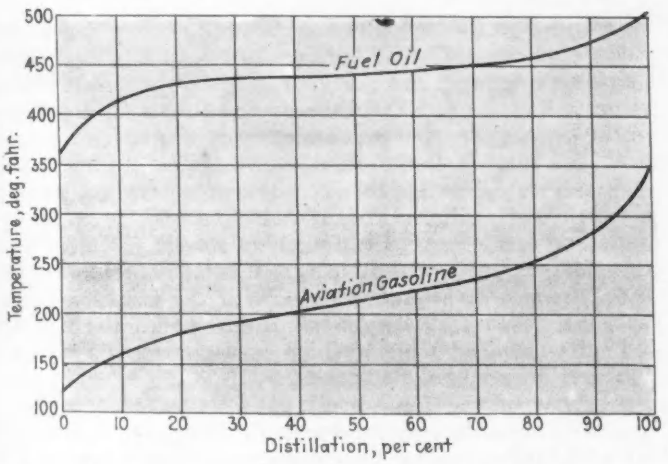


FIG. 5—COMPARATIVE DISTILLATION CURVES OF FUEL OIL AND AVIATION GASOLINE

The Flash-Point, Fire-Point and Specific Gravity Are as Stated Below:

	Aviation Gasoline	Fuel Oil
Flash-Point, deg fahr.	Below Zero	158
Fire-Point, deg. fahr.	Below Zero	175
Specific Gravity, deg. Baumé	65	37

hr. Furthermore, the ignition system of each cylinder is entirely independent of that of the others; so the nine-cylinder radial Diesel can be said to have nine individual ignition systems, whereas the gasoline engine of similar type is dependent upon the functioning of two independent systems, each comprising a great many frail parts subject to failure, not forgetting the possibility that the spark-plugs will fail to function because of the presence of carbon or oil on their surface.

Comparing the two types of engine from the viewpoint of fuel-charge supply, Fig. 4 illustrates the next important advantage of the Diesel engine in that each cylinder is furnished with an individual injection system, whereas the conventional nine-cylinder gasoline aircraft-engine is dependent either on a single carbureter or on a triple-barrel carbureter. In the case of the single-carbureter installation this is usually complicated still further by the need for a rotary distributor of some kind or a low-pressure supercharger intended to improve the distribution of the mixture to the various cylinders, a rather difficult feat to accomplish unaided with a single carbureter. However, even with the three-barrel carbureter there are at best three independent carburetion systems, the failure of any one of which would result in the loss of power from one-third of the operating cylinders. But in the Diesel, as aforesaid, each cylinder is entirely independent of the other cylinders insofar as the functioning of the fuel-injection device is concerned.

FIRE HAZARD VIRTUALLY ELIMINATED

Having discussed the inherent reliability of the Diesel engine from the viewpoint of certainty of ignition functioning, combined with the high degree of dependability of the fuel-injection system, there remain two outstanding advantages in favor of the Diesel for aircraft operation. The first relates to the reduction, if not the total elimination, of the fire hazard common to all aircraft engines using gasoline as a fuel. Fig. 5 illustrates comparative distillation-curves of a good grade of aviation gasoline and an acceptable grade of Diesel fuel-oil. In addition, the comparative flash and fire-points of the two types of fuel are shown, and the greatly enhanced safety of the Diesel fuel-oil is obvious from an inspection of these comparative figures.

Perhaps a more convincing proof of the decreased fire hazard of the Diesel engine can be furnished by citing actual experiences. In laboratory work incidental to the development of new types of gasoline aircraft-engines, gasoline fires are of almost daily occurence. In the course of the laboratory work with our new Diesel aircraft-engine, extending over a year, not a single fire has occurred. There have been innumerable instances of fuel lines leaking or even breaking off; but at no time did a fire result, even when the fuel was flowing in a full stream over the heated engine. Such experiences as these are far more convincing proof of the non-inflammable character of fuel oil than any theoretical analysis of the fire possibilities based on a comparison of the flash and fire-points of fuel oil and gasoline respectively. I believe that experience in this respect warrants the statement that fire after a crash of an airplane equipped with a Diesel engine would be virtually impossible, and could occur only if the engine continued to run wide-open with fuel oil poured directly into the exhaust flame, an almost unbelievable contingency.

ECONOMICAL FUEL-CONSUMPTION

We now come to the consideration of what always has been represented as the most important advantage of the Diesel aircraft-engine; namely, economy in fuel consumption. I have purposely subordinated this question to those of safety and reliability, recognizing that at present these latter qualities are of far more importance to the healthy growth of the industry than are questions of economy. Once it has been proved that the Diesel engine excels in safety and reliability for aircraft use, then the clinching arguments in favor of its universal adoption will be found in its far superior fuel-economy as compared with gasoline engines.

So much has been written on the subject of fuel consumption that it is difficult to find any unexplored territory. The best that I can hope to do is to view the subject from perhaps a new and different angle. These

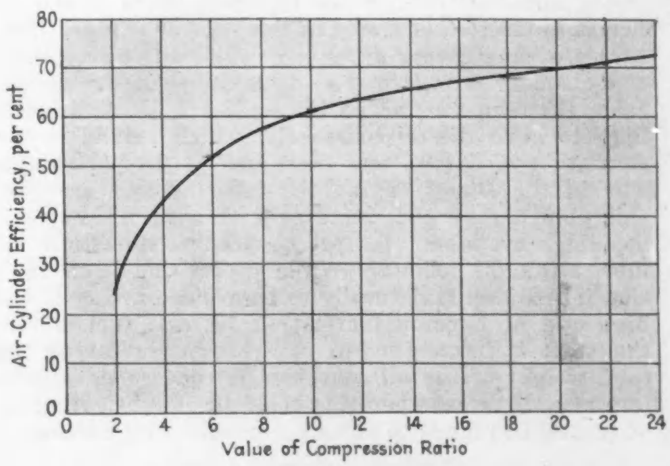


FIG. 6—AIR-CYCLE EFFICIENCY

In the Following Equation, E Represents the Percentage of Air-Cycle Efficiency and r the Values of the Compression Ratio. The Equation Is: $E=1-(1/r)^{1.4-1}$

viewpoints are pictured in Figs. 6 to 8. The fact that thermal efficiency is a function of compression ratio or, rather, expansion ratio, which means the same thing in the conventional engine, is well known to all students of thermodynamics. Considered from the much maligned air-cycle basis, we obtain a relationship such as is shown in Fig. 6.

Translated into practical terms, we secure in actual aircraft-engine operation over the range of cruising speeds the specific fuel-consumptions for gasoline and for Diesel engines that are shown in Fig. 7. The fuel-consumption performance represented by the gasoline-engine curve is certainly better than is usually obtained in practice, and can be considered as almost the best obtainable when using compression ratios suitable for operation with standard aviation gasoline. The Diesel-engine fuel-consumption curve represents the average of many tests which have been checked by actual fuel-consumption readings in the air. Compression ratios as high as 18 to 1 have been used in this Diesel aircraft-engine-development work, such ratios assuring prompt starting and satisfactory performance at altitudes represented by the ceiling of the Stinson-Detroiter airplane used in these tests.

Fig. 8, taken from a recent paper by J. G. Vincent entitled, Various Types of Internal-Combustion Engines and Their Fuel Requirements, illustrates convincingly the tremendous savings in fuel cost when comparing the operation of a Diesel with that of a gasoline engine. The prices represent recent quotations in Detroit for delivery of the fuels of various types in tank-car lots.

With aviation gasoline at 19.8 cents per gal. and a specific fuel-consumption of 0.52 lb. per b.hp-hr., the gasoline engine costs for fuel 1.70 cents per b.hp-hr. The Diesel-engine corresponding cost is 0.35 cents per b.hp-hr., about one-fifth as much, and represents a fuel-cost saving of not less than 80 per cent. A dual advantage is gained with the Diesel because the fuel is of a much cheaper grade and the weight of fuel to be carried for any given cruising range is considerably less with the Diesel than with the gasoline engine, thus making it possible either to extend the cruising range or to carry more pay-load.

Another point favorable to the Diesel aircraft-engine is that lubricating oil is consumed cleanly to produce power and thus contributes its small share to the efficient production of power in this type of engine. Any excess of lubricating oil in a gasoline-engine combustion-chamber is regarded as extremely undesirable, because the temperatures on the walls are not sufficiently high to burn the oil completely, which results in the formation of carbon and in trouble with spark-plugs. But in the Diesel engine the temperatures are considerably higher and, an excess of oxygen being invariably available, perfectly clean combustion of lubricating oil follows. While excessive oil-consumption in a Diesel is naturally to be avoided owing to the high cost of burning lubricating oil as a fuel, nevertheless it is interesting to realize that, so far as the total weight of the oil consumed is concerned, it matters very little whether this consists of lubricating or of fuel oil in regard to miles per pound of oil carried.

Cooling and Other Diesel Features

The air-cooled Diesel engine presents far fewer cooling problems than does the air-cooled gasoline engine. First, high cylinder-head temperatures which must be avoided in the gasoline engine to prevent preignition and detonation offer no serious handicap to the Diesel-engine designer. Similarly, exhaust-valve conditions seem to be far more favorable in the Diesel engine than in the gasoline engine because exhaust-gas temperatures are considerably lower on account of the high expansion-ratio employed; and for the same reason there is a considerable diminution of noise caused by the exhaust. Further, very little visible flame is ejected from the exhaust ports, and it has been found feasible to fly the Stinson-Detroiter equipped with the Diesel engine without exhaust stacks or manifolds, thus eliminating a knotty design-problem which is a continuous source of worry to airplane designers.

Another interesting advantage is that the Diesel aircraft-engine will operate successfully in any position. All carbureting engines are dependent upon gravity for the correct functioning of the carbureter; consequently, the gasoline engine will not continue to run beyond certain angles of inclination dependent upon the carbureter design. While this factor enters more into the stunting of pursuit airplanes than into any other phase of flying activities, it is a source of comfort to know that, should a plane be placed in some abnormal position on account of disturbed air-conditions or other causes, the engine will continue to function satisfactorily, which is true with the Diesel engine and is not true with the carbureting engine.

The acceleration of the Diesel aircraft-engine is at all times excellent, regardless of the temperature conditions or how long the engine has been idling. This is in marked contrast to the performance of gasoline engines which must be nursed carefully on a long glide, especially in cold weather, to assure that the engine will accelerate promptly in the event of full engine-power being required previous to making a landing.

The Diesel aircraft-engine is not affected by rain or water in quantities that would seriously interfere with a gasoline engine. Primarily, this is because there are no high-tension electric currents to be short-circuited by water, but the question of a single carbureter air-inlet also enters. For example, in taking off with a seaplane it frequently happens that, just at the critical instant when the plane is about to get up on its step and every bit of available power is required, considerable water will either be shipped directly into the carbureter, which necessarily is in a disadvantageous position because of being down low on the usual air-cooled engine, or the propeller will pick up water and cause the same result. The engine will then choke and lose revolutions, necessitating a fresh start. A Diesel aircraft-engine has been run for many hours without the slightest disturbance in excessively heavy downpours which undoubtedly would cause serious missing, if not stoppage, of a gasoline engine.

Power Output Considered

On the basis of power output per unit of piston displacement, the Diesel aircraft-engine falls considerably short of the best gasoline-engine practice. Or, expressed in other terms, brake mean effective pressures as high as 130 to 140 lb. per sq. in. are readily obtainable in well-designed gasoline-engines, but a brake mean effective pressure of 100 to 110 lb. per sq. in. can be considered a good achievement with a high-speed solid-fuel-injection oil-engine. However, it should be

borne in mind that these latter figures apply to the rated power-output which the Diesel-engine is capable of sustaining for long periods, and that the need for perhaps 25 per cent of excess air above the amount required to furnish sufficient oxygen to combine with the fuel and thus assure complete combustion has been taken into consideration. But it is feasible to overload the Diesel engine so that nearly all of the excess air combines with the additional fuel. When this is done combustion is no longer as complete or efficient as is desired for normal running; but a considerable increase in power can be obtained at the expense of fuel economy, and this procedure in the case of an aircraft engine is not only permissible but desirable during the comparatively short periods that maximum power is required, such as during the take-off and, occasionally, during climb.

This extra margin of power that can be obtained from a Diesel engine represents a very important item which must not be overlooked in making weight comparisons between the gasoline engine and the Diesel engine. The gasoline engine is rated at approximately its maximum power for any given speed, but the Diesel engine is rated for the power corresponding to some standard of fuel-combustion efficiency which has been determined upon previously. If it should be desired to exceed this standard of specific fuel-consumption during occasional running periods as outlined, the Diesel engine will respond with very gratifying increase of power for such emergencies and, obviously, the small increase in fuel consumption during these extremely short periods cannot materially affect the total fuel consumption on any particular flight, because the time during which the engine is used uneconomically represents such a very small fraction of the total.

Engine Interference with Radio

Another benefit derived from the use of the Diesel aircraft-engine relates to radio interference. With the gasoline engine, which uses high-tension current for ignition, interference from this source has been very great and especially so with reference to the reception of radiophone messages. It has been found that the

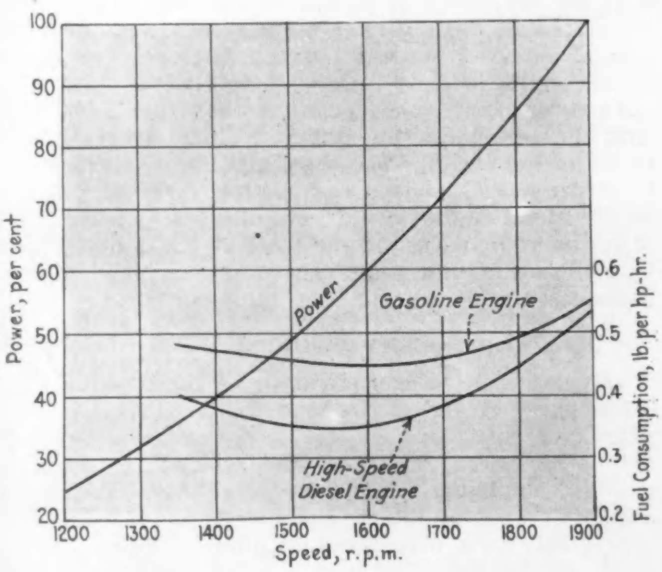


Fig. 7—Comparative Fuel-Consumption on Propeller Load

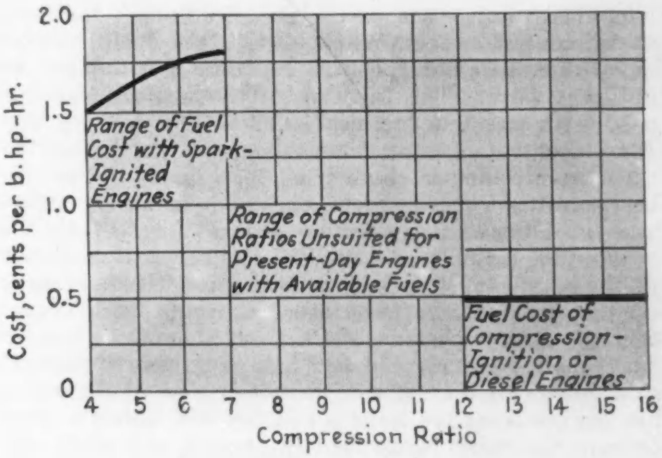


Fig. 8—Cost of 1 B.Hp-Hr. With Various Fuels in Different Types of Internal-Combustion Engine

Type of Engine	Otto Cycle					Diesel Cycle	
	Spark Ignition					Compression Ignition	
Fuel	Kerosene	Motor Gasoline	Ethyl Motor Gasoline	Aviation Gasoline	Ethyl Aviation Gasoline	Furnace Oil	Diesel Oil
Compression Ratio	4:1	4½:1	5½:1	5½:1	7:1	12 to 16:1	12 to 16:1
Specified Gravity, Deg. Baumé	44	59	59	63	63	38	24
Cost, cents per gal.	12.7	14.8	17.8	19.8	22.8	10.2	7.0
Weight, lb. per gal.	6.72	6.17	6.17	6.04	6.04	6.94	7.57
Cost, cents per lb.	1.89	2.40	2.88	3.28	3.78	1.47	0.93
Weight, lb. per b.h.p.—hr.	0.80	0.65	0.60	0.52	0.48	0.38	0.38
Cost, cents per b.h.p.—hr.	1.51	1.56	1.73	1.70	1.82	0.56	0.35

interruption of the primary current and the creation of each high-tension spark result in wave emissions from both primary and secondary conductors as well as spark-plug terminals and all other exposed conductors. These impulses are impressed on the receiving apparatus in the airplane so powerfully as to compel the adoption of radio-shielding means which, in themselves, have a boomerang influence on the ignition system.

While I am entirely willing to admit that a satisfactory compromise can be found, there is no question that the liability of the ignition system to break down is greatly increased by the radio-shielding means, which necessarily include the provision of metal in close proximity to all live parts of the circuit. The elimination of radio interferences promises to be a problem of extreme importance, because it is the consensus of opinion that only through the use of radio will blind flying through fog and thick weather ultimately be possible. If this proves to be true, it is natural to assume that clear reception free from the interference of electrical engine-ignition systems will be of paramount importance, and the use of Diesel engines will grealy facilitate this condition.

Effect on Airplane Design

As to the effect of Diesel aircraft-engines on airplane design, a minor consideration but one of interest is the matter of engine controls. These are very much

simplified in the case of the Diesel engine. Electric-spark control is eliminated, and the fuel-injection quantity can be controlled in any one of a number of different ways. The function of the altitude control used with gasoline engines is admirably met by the Diesel control; for example, should it be desired to cause an airplane to climb from the ground with wide-open throttle with the Diesel engine, it is merely necessary as altitude is gained to reduce the fuel supply without appreciably affecting the number of revolutions of the engine, just as is done with the altitude control of the usual aircraft-engine carbureter. However, there is this important distinction; should the Diesel fuel-supply be made too lean, the engine will merely slow down, whereas, if the altitude control of the gasoline engine is set too lean, the engine will either misfire or quit, the result being that in practice the pilots are cautious about utilizing the altitude control to the fullest extent.

Incidentally, in a multi-cylinder aircraft engine the use of the altitude control is always limited by the cylinder receiving the leanest mixture, it being well known that perfect distribution of exactly the same quality of mixture to all cylinders is practically impossible to obtain. In the case of the Diesel engine, close regulation of the same quantity of fuel injected to each cylinder can be secured readily and, even if these respective quantities of fuel should vary appreciably, the engine would still continue to function perfectly without any of the "spitting-back" behavior encountered with the gasoline engine suffering from uneven distribution.

The major influence, however, which Diesel engines can be expected to exert on airplane design is in regard to the number of powerplants employed. It is well known that, aerodynamically, the most efficient airplane is one powered with a single engine. Twin-engined and three-engined airplanes have been developed largely with a view to assuring continued operation should one engine fail. In some instances multi-engined planes have been necessitated by the lack of powerplants of sufficient size to give in a single unit the power required. However, this phase of the situation can be considered merely as a transitory one, since nothing has transpired in aircraft-engine design which sets any reasonable limit on the power output for a single engine. In fact, it can be stated with confidence that the engine designers are ahead of the plane designers insofar as meeting their demands in this respect is concerned, although, should there be an immediate demand for, say, a 3000-hp. aircraft engine, it probably would have to be constructed in a water-cooled type rather than in the more popular air-cooled variety.

Compression Ignition Increases Safety

Neglecting the temporary condition which arises from time to time and results in multi-engined installations being selected on the basis of available power-units, we are faced with considerations of safety as affected by utilization of multi-engine principles. The gasoline engine which has hitherto been used exclusively as an aircraft powerplant is notoriously one of the most delicate prime movers available. By this is meant that, no matter how robust the design of the engine may be, its continued operation depends vitally on the correct functioning of many small parts which from their very nature cannot be made as sturdy as could be desired. Both ignition and carburetion systems are replete with instances of this kind. A few months' experience with an engine operating on compression ignition will convince even the most biased of engineers that a most important move in the direction of safe aircraft-engine operation results from dispensing with the electric ignition system of the gasoline engine.

Reliability Comparisons

In further reference to questions of operating reliability of the aircraft-engine carbureter and that of the Diesel fuel-injection system, it has been argued previously that the Diesel aircraft-engine has greater inherent reliability in respect to fuel-injection means than has a gasoline aircraft-engine in relation to its carburetion system. Interruptions to the fuel supply of the gasoline engine are frequently caused by dirt in the fuel. This could happen as readily with the Diesel as with the gasoline engine. However, with the oil-injection system only one cylinder will be affected, but if dirt lodged in the main jet of a single carbureter of a nine-cylinder gasoline engine, the engine would stop because of the complete cutting off of the entire fuel supply.

Aircraft-engine carbureters are subject to troubles of their own on account of ice or snow formation on the throttles when operating in cold, damp weather. Many forced landings have resulted from this trouble, which can be avoided by the proper application of heat, but this requires an additional manual control to prevent loss of power at higher operating-temperatures. The Diesel engine is immune from such troubles and, so far as experience has shown, operations in temperature ranging from 18 to 95 deg. fahr. have been uniformly satisfactory. Granting, then, that from both an ignition and a fuel-feeding viewpoint the outstanding advantages of the Diesel lie in its inherent reliability, we are prepared to consider the point that a plane equipped with a single Diesel engine has all the reliability characteristics of a three-gasoline-engine plane. The three gasoline engines would each be equipped with two ignition-systems, making a total of six independent ignition-systems; each consisting of several hundred separate parts; whereas, the single Diesel engine with its nine cylinders would have nine independent ignition-systems and the added advantage that the Diesel ignition-system requires no additional parts on the engine. The three gasoline engines would have three independent carbureting systems and the single Diesel engine would have nine independent fuel-injection systems; so, on the score of reliability gained by duplicating important elements, the Diesel engine possesses a wide margin over its competitor.

Reliability of Engine Parts

We now come to consideration of the reliability of other parts of the engine and, to do justice to this phase, we must consider one new distinction between the operation of the Diesel and that of the gasoline engine. Maximum cylinder-pressures in the Diesel are absolutely fixed by the design, and these are not varied appreciably by a wide range of different fuels. Maximum cylinder-pressures in a gasoline engine may vary over a range as high as 3 to 1, considering the case of an engine detonating because of a poor grade of gaso-

line, hot exhaust-valves, hot spark-plugs or overheated cylinders. In other words, detonating pressures in a gasoline engine approximate the maximum cylinder-pressures of the Diesel aircraft-engine, but it should be noted that the Diesel engine is designed and ground-tested to withstand these pressures over long periods of time; whereas, the gasoline engine is invariably ground-tested under ideal conditions with detonation suppressed.

On the other hand, it frequently happens that an aircraft gasoline-engine of relatively high compression will be operated on commercial motor-gasoline on account of inability to secure a supply of aviation gasoline. It thus becomes necessary for the pilot to fly considerable distances with the engine detonating, or, in normal operation, detonation may set in because of failure of one ignition-system or for other reasons. These detonating pressures for which a gasoline engine is not designed invariably result in serious damage to the engine if allowed to persist for any length of time. Piston seizure from this cause is common, and crankshaft failure is by no means unknown. The point to be emphasized is that the gasoline engine is occasionally abused either through carelessness or as a result of an emergency, so that it is very liable to failure from this cause. The Diesel engine cannot be abused, as there is no way in which the operator can increase the maximum cylinder-pressures over those the engine was designed to meet. Consequently, apart from considerations of ignition and carburetion reliability, it may be necessary to employ three gasoline engines to provide the utmost dependability, because the engines can be abused and to that extent are not fool-proof.

There are perhaps some who would claim extra dependability of the three gasoline engines on the score of having three separate propellers; but, from this viewpoint, this may be considered an extra hazard. Propeller failure, while extremely rare, is also very serious, and if one blade alone suffers damage the resulting unbalanced centrifugal force on the other blade is usually sufficient to tear the engine loose from its mount if not to throw the entire powerplant completely out of the plane, as had happened in a few instances. It is certainly preferable to have a propeller go to pieces on a conventional single-engined plane than on a wing engine of a twin or triple-engined plane, with the possibility of doing serious damage to the fuselage or controls.

Taking all things into consideration and without reference to the important aerodynamic advantages of the single-engined plane, it seems that the advent of the Diesel aircraft-engine brings about the necessity for thoroughly reviewing the subject of single versus multi-engine airplanes. In the final analysis, any transportation system must justify its existence on economic grounds, and the cost of operation of a single-Diesel-engined plane as compared with a three-gasoline-engined plane must be in the order of at least one to four, which constitutes an inducement that no transportation executive can afford to ignore.

Summary

The advantages of Diesel engines for aircraft are covered in the following statements:

(1) The Diesel engine is inherently far more reliable than the gasoline engine because (*a*) the electric-ignition system is eliminated, and (*b*) a separate fuel-injection means is applied to each cylinder, thus assuring maximum dependability.

(2) The fire hazard is reduced to the absolute minimum.

(3) The specific fuel-consumption is reduced about 20 per cent.

(4) The specific fuel-cost is reduced about 70 per cent.

(5) Open exhaust-ports, eliminating the weight and drag of exhaust manifolds, are permissible from both noise and from night-flying-vision viewpoints.

(6) Engine operation is not affected by temperature or humidity conditions; flexibility of control is assured at all times.

(7) Radio interference is eliminated.

(8) Basic reliability of the Diesel engine justifies a reduction in the number of powerplants in large airplanes, and presages a consequent important reduction in the cost of maintenance and operation of commercial air-transportation facilities.

THE DISCUSSION

CHARLES L. LAWRANCE[4]:—In his data on fuel consumption, Mr. Woolson gives it as 0.43 lb. per b.hp-hr.

L. M. WOOLSON:—The low point of the curve shows it to be about 0.35 lb. per b.hp-hr.

MR. LAWRANCE:—Where a number of different metering devices or fuel pumps are employed, I think it might be very difficult to regulate them so that they all give the same output at all speeds, and that a fuel consumption such as 0.35 lb. per b.hp-hr., which has been attained in Diesel engines, might be difficult to attain in actual practice and on multi-cylinder engines. I think it will be done and that perhaps it has been done. I mention it merely as one of the mechanical difficulties of the Diesel engine. In fact, it may be that some difficulty with the cam mechanism might put all the pumps out of service, which is one of the faults which we note in connection with the gasoline engine.

At what rotational speeds were these results attained? We all know that the Diesel engine has performed very satisfactorily at what we in the aviation field consider slow speeds.

MR. WOOLSON:—The fuel consumption of 0.35 lb. per b.hp-hr. is the minimum attained with all nine cylinders operating. There is no difficulty on account of lack of synchronization of the pumps because the specific-fuel-consumption curve is extremely flat in that vicinity and should one cylinder be doing slightly more work than the others, this is not reflected in any appreciable change in the over-all fuel-consumption of the engine. That is in direct contrast to the gasoline en-

[4] M.S.A.E.—President, Wright Aeronautical Corp., Paterson, N. J.

gine, in which the best results can be obtained with a single-cylinder engine provided all frictional horsepower losses are accounted for generously, because the multi-cylinder gasoline-engine cannot run with any leaner mixture than that at which any one cylinder will operate. When that cylinder starts spitting back, all the carburetion is upset. With a Diesel engine all the pumps do not need to be synchronized, because none of them will be far enough away from the flat point on the curve to affect the over-all result.

We have no definite ideas as to what the standard number of revolutions of the engine should be. Most of the runs are from 1700 to 1800 r.p.m.; at full speed in the air, the engine speed is 2000 r.p.m.

QUESTION:—Is any difficulty experienced on account of contamination of the lubricating oil by the fuel in a Diesel engine? What is the weight of the engine per horsepower output?

MR. WOOLSON:—Temperatures are high enough not only to burn up the fuel oil but also the lubricating oil. Dilution may be a problem in low-speed engines, but in high-speed engines it is not a problem. The weight of the engine is less than 3 lb. per b.hp.

MR. LAWRANCE:—Do not the high temperatures of the Diesel engine cause piston trouble which is not experienced in an internal-combustion engine of the automobile type?

MR. WOOLSON:—We consider 450 deg. fahr. at the hottest point of the cylinder-head high, and I believe that Mr. Lawrance will regard that temperature as very low.

MR. LAWRANCE:—No, that is about right.

Relation of Weight to Fuel Consumption

CHAIRMAN E. T. JONES:—What is the relation between the specific engine-weight and specific fuel-consumption? With the conventional internal-combustion engine of the Otto-cycle type, we can reduce the specific fuel-consumption tremendously if we are prepared to utilize higher specific-weights and special fuels. As pointed out by Mr. Woolson, and contrary to the general belief, working on the same compression-ratios with the same expansion-ratios, the constant-volume cycle is a more efficient cycle than is the constant-pressure or what is commonly known as the Diesel cycle. By using special fuels and reducing the output of the engine, it is possible to obtain fuel consumption of the order mentioned in connection with the Diesel engine in the ordinary internal-combustion engine. Apparently, to date, developments have been along such lines that it has not been thought wise to do that, but I feel sure that with the fairly conventional internal-combustion engine we can hope to get fuel consumption of the order of 0.36 or 0.37 lb. per b.hp-hr. However, it is only fair to state that, to obtain such a fuel consumption, it will be necessary to use very special fuels, and probably rather expensive fuels, as compared with those used in the Diesel engine.

A MEMBER:—Mr. Woolson has said that any type of fuel oil would function satisfactorily in his Diesel engine. Does he mean that literally?

MR. WOOLSON:—We have tried two or three different grades of available oil and they work equally well. In fact, the cheaper grades work somewhat better than the furnace oil which we use because it is the only kind of Diesel-engine oil commercially available in Detroit. The furnace-oil viscosity is entirely satisfactory for all operating temperatures.

A MEMBER:—Has any difficutly been experienced with the trapping of air in the fuel lines? That occurs especially with the radial engines. Tests that I have conducted show that an infinitesimally small amount of fuel is to be metered out and brought into the engine cylinder. If the smallest particle of air is trapped so that it acts as a cushion, the fuel will not reach the cylinders. That condition is not serious with the large marine Diesel engines but it is serious in the small engines, especially in the radial engine on which the pumps are all located in different positions. The slightest leak may cause an air-pocket to be formed and, in consequence, some cylinders will not function.

MR. WOOLSON:—That is a theoretical trouble which we anticipated would give us considerable difficulty, but we have never had the slightest trouble from that source.

Radial Air-Cooled Diesel Very Promising

HUGO K. MORAN[6]:—The recent historical flight made with the aid of a Diesel engine has stirred many engineers to investigate the possibility of using Diesel engines of larger capacities. On account of previous experiences, I have studied the possibilities of the two-stroke-cycle valveless engine as a radial air-cooled Diesel. After favorable results with a small $2\frac{3}{4}$ x 7-in. twin parallel-cylinder engine—as, for example, a brake mean effective pressure as high as 125 lb. per sq. in. and a consumption of 0.280 lb. of fuel oil of 28 to 32 deg. Baumé per indicated horsepower at 1300 r.p.m.—I am convinced that a radial engine of the same type is not only feasible but is a highly promising type for high power-output.

For instance, a nine-cylinder radial engine of the foregoing type with 4 x 7-in. cylinders would be good for 600 b.hp. at as low a speed as 1350 r.p.m. In this connection it should be pointed out that the frontal area of this engine is the same as that of a nine-cylinder radial with a 4-in. bore and with no valve in the head. The cooling of an engine of this type will be easy because of a very low exhaust temperature. The experimental engine already mentioned showed an exhaust temperature of between 550 and 650 deg. fahr. with a brake mean effective pressure of 85 lb. per sq. in. at 1200 r.p.m. The necessary amount of cooling water to keep the outlet temperature at 110 deg. fahr. was exceptionally small.

Against these favorable points must be set a requirement of a great amount of scavenging air that has to be provided for by a rotary air-pump of some design. In this connection, I refer to an expression of Mr. Chorlton, of Beardmore, Glasgow, Scotland, as follows:

> The problem of air supply is really one of obtaining a highly efficient air-pump. If a pump having an efficiency of 80 per cent can be produced, the scavenging supercharging engine undoubtedly will develop. Using a centrifugal type, the efficiency is often but 50 per cent and the loss of power required to drive it militates greatly against the extensive use of this method. One must not overvalue, in this comparison, the result of the racing motor-car which really competes by over-rating on an obsolete formula.

[5] M.S.A.E.—Chief powerplant engineer, Wright Aeronautical Corp., Paterson, N. J.

[6] M.S.A.E.—In charge of gasoline and high-speed Diesel-engine development, American Machine & Foundry Co., Brooklyn, N. Y.

Regarding an efficient air-pump which will appear in the near future, I picture an eccentric-rotor pump with two sealing rollers balanced to avoid all but the rolling friction. Efficiencies up to 90 per cent might be obtainable at 1000 r.p.m.

Among the other details of a radial air-cooled Diesel engine, the fuel-injection device holds an important position. This detail can be developed advantageously by modification of an injection device in common use with stationary Diesels. The other details of a powerful radial Diesel engine may not vary much from regular gasoline engines of the same type. I feel that the powerful two-stroke-cycle radial Diesel, either air or water-cooled, is just knocking on the door.

Problems of Motorcoach Design and Manufacture

(*Concluded from p.* 172)

automobile performance, and to show in a general way what are some of the difficulties of its attainment, cannot fail to make a favorable impression.

To allay the fears of operators who have purchased or are about to purchase equipment, as to the possible proximity of major motorcoach design-changes and new developments, I should like to say that such fears are, to the best of my knowledge and belief, groundless. In short, we are not on the eve of startling events. It is, of course, evident that the more important manufacturers are carrying out experimental and developmental projects of one kind or another, but manufacturers have learned from experience that it is wise to make haste slowly; otherwise service costs soon absorb profits and dissatisfied customers mean an immediate and permanent loss of business.

One last point is that the thought behind all of the issues raised in this discussion is admirably conveyed by that famous slogan, whose author is, I think, responsible more than any other man for the amazing achievements of the American automotive industry; the necessity for "keeping an open mind."

Aviation Industry Offers Opportunity

THAT tremendous strides have been made in the aviation industry during the last 18 months is forcibly brought out in a survey of the subject prepared by Otis & Co., investment bankers, of Cleveland. According to this survey, during the year 1925 a total of 789 planes were produced in this Country, as compared with 1186 in 1926 and 1995 in 1927, or an increase of 153 per cent in two years. The prospect is that the current year will see a further substantial gain in the production of airplanes, and that the longer-term trend of production and sales also will be definitely upward.

Scores of manufacturing and transportation companies have been formed during recent months, and many other companies have added an aircraft sideline to their already established businesses. The number of airports and landing-fields has increased in a very similar manner, there being at the present time well over 1000. Nevertheless, present facilities are inadequate to meet the requirements necessitated by the growth of the industry. Present plans call for several hundred additional airports, which are being fostered by large municipalities and private interests. These plans both encourage further development and reflect the attitude with which the new industry is being received.

An interesting report recently issued by the aeronautics branch of the Department of Commerce enables one to appreciate better the present status of aviation. On Sept. 15, 1928, not quite 25 years after the first flight, there were 18,459 miles of airways operating. This was more than double the number of miles of railroads, 9021, in operation on the twenty-fifth anniversary of the railroad in 1850. On Sept. 30, 1928, there were listed 600 air-service operators, 1400 concerns and individuals in the aviation trade directory, 3106 licensed pilots, 2221 pilot-license applications pending, 6475 student permits issued or pending, and 4496 mechanics' licenses issued or pending.

Under the heading, Air Mail Lines, the Bureau of Aeronautics reported 20 contractors operating, 27 lines in operation, 17,701 miles of mail lines operating and to operate, 26,240 miles flown daily with mail, and 1,654,165 lb. of mail carried during 1927, including three foreign lines, of which 1,449,364 lb. were carried on internal lines.

Summarizing briefly, the report concludes that the aviation industry at present seems to be in a position fairly comparable with that of the automobile and radio industries during periods of their infancy. The outlook appears essentially the same, possessing great opportunities for business initiative on the part of manufacturers and operators, together with possibilities of tremendous profits for the astute investor.—From *Weathervanes*, published by the Union Trust Co.

Reports of Society Committees

Meetings Committee Report

Before the close of the Annual Meeting, the Meetings Committee hopes to announce the time and the place for the 1929 Summer Meeting of the Society, a questionnaire having been sent to the members on Dec. 24, putting to a vote the relative advantages of French Lick Springs, Mackinac Island, Saranac Inn and Spring Lake.

During the year 1928, six meetings of the Society have been held, the attendance at these meetings having been indicative of the value of the technical programs arranged by the technical committees appointed. The total attendance for all meetings for 1928 is 25 per cent greater than for the meetings held during 1927. The time, place, number of sessions, number of papers presented, and the attendance are given in the table at the bottom of this page.

The success of the meetings is to be credited to the Technical Program Committees appointed, the personnel of which is as follows:

SUMMER MEETING

W. R. Strickland, *Chairman*

F. K. Glynn
A. W. Herrington
L. C. Hill
G. L. McCain
H. L. Towle
H. T. Woolson

AERONAUTIC MEETINGS

Glenn L. Martin, *Chairman*

Ethelbert Favary
E. S. Land
E. D. Osborn
Edward P. Warner
L. M. Woolson

TRANSPORTATION MEETING

F. C. Horner, *Chairman*

H. F. Bacon
W. F. Banks
H. R. Cobleigh
C. J. Fagg
F. K. Glynn
A. W. Herrington
C. E. Holgate
E. F. Loomis
P. J. O'Toole
R. E. Plimpton
T. L. Preble
Martin Schreiber
A. D. Way
J. F. Winchester

PRODUCTION MEETING

E. P. Blanchard, *Chairman*

J. B. Armitage
A. R. Fors
G. Walker Glimer, Jr.
Guy Hubbard
Erik Oberg
John Younger

The Meetings Committee feels that the success of these meetings has largely been due to delegating responsibility for the technical programs to the special committees. These technical program subcommittees have thus been functioning along the lines of the proposed Society reorganization, as the subcommittees correspond to the proposed Professional Activities Committees.

JOHN A. C. WARNER,
Chairman.

1928 S.A.E. NATIONAL MEETINGS

Date	Meeting	Place	Registration	Sessions	Papers
Jan. 24 to 27	Annual	Detroit	1,049	10	23
June 26 to 29	Summer	Quebec	851	9	21
Sept. 11 and 12	Aeronautic	Los Angeles	400	5	15
Oct. 17 to 19	Transportation	Newark	460	8	13
Nov. 22 and 23	Production	Detroit	278	5	14
Dec. 5 and 6	Aeronautic	Chicago	332	3	10
			3,370	40	96

Membership Committee Report

The Membership Committee takes pleasure in announcing that the last year has been one of the most successful in the recent growth of the Society. The present campaign plan of close cooperation between all National and Sectional membership activities has now been in force for two years, and it is believed that this work has played a major part in the results accomplished.

We have therefore summed up the activities at the close of 1928 in the following figures and compared them with the same results in 1927 and 1926.

	Dec. 31 1928	1927	1926
Applications for membership received	1,058	929	881
Percentage of applicants qualifying	68	70	88
Membership by grades			
Members (including Foreign and Service	3,511	3,284	3,095
Associates	2,088	1,960	1,858
Juniors	595	560	503
Affiliates	110	110	110
Affiliate Member Representatives	183	191	197
Total	6,487	6,105	5,763
Enrolled Students	434	355	221
Grand Total	6,921	6,460	5,984

The Membership Committee wishes to express its sincere appreciation to the members of the Society who assisted in aiding this growth of the Society. The Section Membership Committees also are to be complimented on their active interest in the work.

F. K. GLYNN,
Chairman.

Operation and Maintenance Committee Report

During the last year the Operation and Maintenance Committee, which was originally organized in 1926, has made appreciable progress, although, as outlined in the general report published in the December, 1928, issue of THE JOURNAL, little has been accomplished in the transportation research program that was proposed at the Transportation Meeting in Chicago in 1927. The Committee's work has been

more clearly defined than previously and was carried on almost entirely through the following Subcommittees:

(1) Forms for vehicle data-sheets suitable for listing information furnished by vehicle manufacturers on subjects such as clearances, tolerances, fits, interchangeability, replacement parts, and maximum load-allowances on vehicles. Also to keep records uptodate when changes are made in the construction of vehicles after their purchase. [Report of the Subcommittee to be published in an early issue of THE JOURNAL.]

A suggested form for these mechanical information sheets was published in THE JOURNAL, principally to secure suggestions and data for the Subcommittee's work; and a progress report was made at the Society's annual Transportation Meeting in Newark, N. J., last October. The Subcommittee is continuing its work with a view to submitting a definite proposal.

(2) Study of effect on vehicle maintenance of the use of such accessories and parts as air-cleaners, oil-filters and shock-absorbers. [Report of Subcommittee to be published soon in THE JOURNAL.]

This Subcommittee sent out an inquiry on the use of such accessories. A careful survey was made of the experience of the operators on the Pacific Coast, the result of which was the presentation of a valuable report at the Transportation Meeting.

(3) Selecting and training of mechanics and their payment. Time-study. [Report of Subcommittee published in THE JOURNAL, January, 1929.]

This Subcommittee was organized on a somewhat broader basis than the others by adding several men of broad experience to its personnel. It also presented a report embodying a number of tentative recommendations at the 1928 Transportation Meeting, one of the more important of which was that the Society might properly develop a standard course of mechanics' training to be introduced into the trade schools.

(4) Man-power (mechanics, washers, etc.) required per vehicle operated. Seasonal fluctuation in man-power requirements. [Report of Subcommittee published in THE JOURNAL, November, 1928.]

A comprehensive questionnaire was sent out by the Subcommittee to a large number of motorcoach and motor-truck fleet operators throughout the Country. The report of the Subcommittee at the 1928 Transportation Meeting was more in the nature of detailed information on the economics of the subject than of definite recommendations. The Subcommittee is continuing its study of this general topic.

(5) Drivers, their training, selection and payment. Operating safety-measures. [Report to be published later in THE JOURNAL.]

After making an exhaustive study of its assignment, this Subcommittee presented an extensive report relating to practices involved in selecting and training vehicle operators, and for maintaining a satisfactory standard of personnel performance. The report also dwelt at some length on safety features involved in fleet operation, and those responsible for maintaining such safety.

(6) Budgeting methods and practices. Purposes for which operating expense and cost are compiled

A report by this Subcommittee was printed in the February, 1928, issue of THE JOURNAL. It contained a rather detailed classification of costs and a statement of the uses to which the data are put in a motor-transport business.

(7) Administrative systems and methods and the paper-work involved. [Report published in THE JOURNAL, December, 1928.]

By reason of its connection with a variety of motor-vehicle fleet operations, this Subcommittee was enabled during the year to draw on a wide field of information in the preparation of a report that was presented at the 1928 Transportation Meeting of the Society. The report, largely one of progress, emphasized the need for establishing an adequate system of cost classification before reliable comparative operating statistics, which are vital in motor transportation, can be had. The detail information given was sufficiently descriptive to be of value to almost every class of motor-vehicle fleet operation.

At the last Transportation Meeting, the Chairman of the Operation and Maintenance Committee presented a general report reviewing the work of the Society since 1923 as related to problems of motor-vehicle utilization as distinguished from those of design and construction. He indicated in the report that fleet operation offers a definite field for the Society's standardization activities, and that much can be done through the publications of the Society to help further the work of the Committee and to make the Society of increasing value to the operators.

The Subcommittees, and particularly Subcommittees 1, 3 and 4, are continuing study of their assignments, looking toward the presentation of more specific recommendations during this year. Meantime, a roster of large-fleet operators in various fields of transportation is being developed for the Committee. It includes the administrative personnel and other valuable information about each company. It is hoped that, by means of this roster, the result of the Committee's activities can be broadcast effectively and will result eventually in much increased representation of this branch of the automotive industries in the Society's membership.

R. E. PLIMPTON,
Chairman.

Production Committee Report

The experience gained by the Production Committee, following its organization in 1927 as the Production Advisory Committee of the Society, led to a general conference of production executives and engineers at the Annual Meeting of the Society in Detroit in January, 1928, at which time a frank and full discussion was had regarding the Society's production activities. Largely as a result of this conference, the Production Committee of 1928 was supplemented by a Production Advisory Board, whose members comprised chief executives of a number of large automobile companies, while the Production Committee membership was divided into seven Subcommittees as follows:

(1) MATERIAL HANDLING

The scope of this Subcommittee's study was the relation between stocks and schedules; internal transportation (hand-trucks, power trucks, unit conveyors, continuous conveyors, etc.); functions of conveying systems; where to change from "stock in processes and periodic moving" to "no accumulation in processes and continuous moving"; and relative costs of transportation methods under given conditions.

(2) PROCESSES AND EQUIPMENT

The Subcommittee was to review lapping practices, suggest machine-tool standards, and develop belt and power-transmission recommendations. It also was to study the proportional significance of man, machine and method, and their relation to quality in cost; comparative machine-cost for malleable castings and steel forgings; and the economic consideration involved in selecting new machinery.

(3) TIME-STUDY AND PERSONNEL RELATIONS

The Subcommittee devoted considerable time to time-study methods used; the fatigue factor in rate-setting; compari-

son of the Dyer and Bendaux and older systems; and a general analysis of these practices in the automotive industries.

(4) PRODUCTION EXPENSES (COSTS AND BUDGETS)

Practices for depreciation and obsolescence of equipment; cost methods used in the industry, and a study of the cost of production control, and how much of it is justified, were the basis for this Subcommittee's work.

(5) PRODUCTION STANDARDS

This Subcommittee comprised the Production Division of the Society's Standards Committee. It sponsors publication of recommended practices for interchangeability of manufacturing equipment and of methods and processes, as approved by the Standards Committee and also as developed by Committees, other than those of the Society, on which it is represented.

(6) INSPECTION METHODS

Among the subjects for study by this Subcommittee were where to place tolerances, what they should be, their interpretation in inspection, and whether practices for tolerances can be standardized. The study also included the cost of inspection and whether it should be periodic or 100 per cent; the use of fluid gages; and X-ray inspection.

(7) SECTIONS AND MEETINGS

The function of this Subcommittee was to serve as a contact between the design and the production engineers, and to contact with non-members of the Society; the selection of production subjects of interest particularly to members in smaller companies; and to indicate how the Society can be of greatest help to the production man. It also involved a study of the training of the production engineer and the relative responsibilities of the shop man, the inspector and the assembly man.

SUBCOMMITTEE REPORTS PRINTED

Valuable reports that were printed in various issues of THE JOURNAL of the Society constituted an important part of the program of the annual Production Meeting in Detroit last November. The report of Subcommittee 2 included valuable machine-shop-practice information in connection with the use of diamond tools. Unfortunately, the Subcommittee on Inspection Methods was unable to participate in the program of this meeting.

New production-engineering standards that were recommended or approved by Subcommittee 5, acting as the Production Division of the Standards Committee, were adopted and printed by the Society during the year.

Acknowledgment is made of the valuable advice, assistance and support given during the year to the Chairmen and the members of the Committee by the Production Advisory Board, and to the members of the Committee for their hearty cooperation in the difficult task of developing this field of the Society's activities, and especially for their help in making the annual Production Meeting the success it was. The work of the Committee will, it is anticipated, be continued next year with increased vigor for the benefit of its members, the Society and the industries as a whole.

E. P. BLANCHARD,
Chairman.

Publication Committee Report

Beginning with Part I of the 1927 volume of the S.A.E. TRANSACTIONS, the volume was changed from the 6 x 9-in. size (adopted at the time the S.A.E. BULLETIN, the predecessor of THE JOURNAL, was also 6 x 9 in.) to present S.A.E. JOURNAL size, thus making it possible to use THE JOURNAL type without extensive revisions in illustrations or make-up. This change will also make it possible to issue TRANSACTIONS with less delay than formerly. The principal reason for the delay in the past has been the time lost in getting the Committee's decision upon the papers to be included in each volume, only about 60 per cent of the papers appearing in THE JOURNAL for a corresponding period being published in TRANSACTIONS.

Concurrent with the change in size of TRANSACTIONS, the Council authorized their distribution to all members free on request, the practice recently having been to make a charge of $2 per Part. The change in form of TRANSACTIONS has resulted in a decrease in the cost per copy from approximately $4.00 to $1.25, the total cost of the 3000 copies of TRANSACTIONS issued in the new form being $3,786 as against $3,725 for the 842 copies issued in the old small form.

The suggestion has been made that in future the bill for Society dues include a blank form for request for TRANSACTIONS. In this way the Publication Committee will be assured that the question whether a member desires the TRANSACTIONS is brought to his attention.

PROPOSED CUMULATIVE INDEX

The Committee has recognized the need for a cumulative index which would make it possible for members and others to refer to all printed Society papers and reports on a given subject without searching the index to each volume of the S.A.E. BULLETIN, THE JOURNAL, and TRANSACTIONS. The Committee expects to submit in the near future a comprehensive report covering the method of indexing and the form and cost of issuing the cumulative index. It seems that it should be feasible to use the same form as the index to the last issue of TRANSACTIONS (Part 1, 1927), revising the cumulative index every three years, the semi-annual indexes to be used for the intervening years.

PAPERS SUBMITTED AND PUBLISHED

From Oct. 1, 1927, to Oct. 1, 1928, 121 papers were presented at national meetings of the Society and 151 papers at meetings of the Sections. Of these, 70 and 34 papers respectively were or will be published in the S.A.E. JOURNAL. The Committee recognizes that it may not be possible to publish many excellent papers, as decision regarding each paper depends not alone on the merit of the paper, but upon the material previously published, the state of the art, and the percentage of members likely to be interested in the paper. The papers published in the S.A.E. JOURNAL for the year 1928 have been classified as follows:

	Per Cent
General Design and Research	57
Production	12
Transportation	15
Aeronautics	13

During the year further efforts have been made to improve the typographical appearance of THE JOURNAL and to increase its reader interest. It is believed that more can be accomplished along this line, and suggestions from members of the Society will be appreciated.

The following table indicates the volume of material published in THE JOURNAL in recent years:

	1926	1927	1928
Total Pages	3,012	3,240	2,926
Total Text Pages	1,457	1,679	1,510
Percentage of Text to Advertising	48	52	52
National Meeting Papers Published	75	91	58
Section Meeting Papers Published	55	47	38
Separate Discussions Published	35	26	23
Contributed Articles Published	5	4	0

JOHN YOUNGER,
Chairman.

Research Committee Report

The Research Committee and its Subcommittees have continued to devote their attention during the last year to four main projects: fuels, headlighting, highways, and riding-qualities.

FUEL RESEARCH

In conjunction with the representatives of the National Automobile Chamber of Commerce and the American Petroleum Institute, the Fuels Subcommittee has continued its supervision of the cooperative Fuel-Research being conducted at the Bureau of Standards. During the last year the fuel-research work has been concerned with three projects: volatility measurements of gasoline, factors affecting engine acceleration, and methods of rating fuels with regard to knock characteristics.

Previous study of volatility measurements established a correlation between the A.S.T.M. distillation curve and the equilibrium-air distillation, the latter closely approximating the conditions prevailing in an engine manifold. During the last year tests have been made over a wider range of temperatures. Dew-point measurements, that is 100 per cent evaporated, made on a large number of gasolines were found to be accurately related to the 90-per cent A.S.T.M. point by a constant factor. Preliminary work on the bubble-point, that is 0 per cent evaporated, included the development of a method for removing dissolved air from the gasoline samples before making vapor-pressure measurements. Two papers by O. C. Bridegman, one entitled, Dew-Point Data on Gasoline, presented at the Summer Meeting, and one entitled, Vapor-Pressure Data on Motor Gasoline, for presentation at this Annual Meeting, cover the work on volatility.

The year's work on the influence of fuel characteristics on engine acceleration included the development of improved apparatus and test procedure, the effect of air-fuel ratio, of manifold conditions and of fuel volatility. Donald B. Brooks has given the results of these tests in a Summer Meeting paper entitled, The Influence of Fuel Characteristics on Engine Acceleration, and two papers for presentation at this Annual Meeting: Economic Fuel-Volatility and Engine Acceleration, and Operating Factors in Engine Acceleration.

There are two phases of the project on detonation: the construction of an engine suitable for use as a standardized instrument for measuring detonation, and the development of a standardized method of measurement. Work is going forward on the building of a number of engines, and future work will include a series of knock measurements to be conducted by different laboratories represented on the Subcommittee, using these engines. As a preliminary to developing a method of measuring detonation, a bibliography has been prepared on the theoretical aspects of the subject. Consideration has been given to the published work on the relation of ignition temperatures of fuels to their knock rating and to the mechanism of oxidation of hydrocarbons and their tendency to react with oxygen.

The Fuels Subcommittee also has under its technical direction research on vapor lock in airplane fuel-systems as affected by fuel characteristics, this being conducted at the Bureau of Standards with funds provided by the Naturaline Co. of America. The program for this work was approved by the Subcommittee early in September and the work is now well under way.

CARBON MONOXIDE

In response to the current interest in and desire for information concerning the carbon-monoxide content of exhaust gases and its effect on atmospheric pollution, the Research Committee instructed the Research Department to prepare an article summarizing the main points of the general research, and dealing in somewhat greater detail with the following subjects of special interest to the automotive industry: the carbon-monoxide content of air in garages, streets and tunnels, due to automobile exhaust-gases; the physiological effects of such concentrations of carbon monoxide on human beings; and the use of ozone in combating the carbon-monoxide health hazard in garages. The article and bibliography appeared in the May, 1928, issue of the S.A.E. JOURNAL.

The Society is also represented on the Joint Committee on Atmospheric Pollution by Automobile Exhaust-Cases, which was formed early last summer and is now considering plans for investigations.

HEADLIGHTING

The Committee has continued its technical direction of the headlight research being conducted at the Bureau of Standards to determine the basic requirements for safe and satisfactory headlighting, with due regard to protection against glare. The first part of the program consisted of road tests to determine the distance at which an object can be seen under various conditions, supplemented by laboratory experiments. A progress report of this work and a description of test methods appeared in the March, 1928, issue of THE JOURNAL. The discrepancies between results obtained on the road and on the test screen led to supplementary tests, making photographic records indicating the area which should be illuminated. An analysis of these data resulted in certain conclusions regarding beam characteristics which would constitute a satisfactory system of illumination from both the driver's point of view and the point of view of the one who meets it. A demonstration of lighting patterns, including those developed at the Bureau of Standards, held at the General Motors Proving Ground before a diversified group of observers, was reported in the December, 1928, issue of THE JOURNAL.

HIGHWAYS

The Highways Subcommittee is continuing to represent the S.A.E. on the Cooperative Committee on Motor-Truck Impact Tests, under whose auspices the Bureau of Public Roads has been conducting its truck impact tests. The instrumentation problems connected with this research are being studied with the cooperation of the Bureau of Standards, as mentioned in the previous report. A special design of accelerometer calibrating machine has been worked out and its fabrication is nearing completion, as is also a ten-element contact-type accelerometer. An extensive series of tests has been made with satisfactory results by means of the Firestone vibration-machine on a single-cell contact-accelerometer of S.A.E. design. Other contact instruments (Firestone and Bureau of Standards) have been tested. The coil-spring accelerometers of Bureau of Public Roads design are being tested and compared with the other type. It is hoped that a study of the accuracy of the data heretofore obtained will soon be undertaken and completed with the minimum delay.

RIDING-QUALITIES

Prof. E. H. Lockwood has been unable to continue the riding-qualities project undertaken at Yale University, because of pressure of other work. As requested at the Summer Meeting, Prof. H. M. Jacklin drew up and submitted, for the consideration of the Riding-Qualities Subcommittee, a research program to be carried on at Purdue University. The Committee encouraged Professor Jacklin to proceed immediately to explore the actual vibratory motions to which passengers are subjected in automobiles and to make a statistical study of the subjective reactions of a large number of passengers.

In coordination with the program at Purdue, the Committee has approved a program proposed by Dr. F. A. Moss, of George Washington University, for devising and standardizing methods of measuring fatigue. Dr. Moss is

prepared to engage upon the work at once, subject to the securing of funds to meet the necessary expenses.

Wheel Alignment

A year ago the Research Committee authorized the appointment of a Subcommittee to get in touch with tire and motor-car manufacturers, to obtain from them the information that is available on the fundamentals affecting wheel alignment and to assemble and digest the data for presentation in a paper before the Society.

The Subcommittee has been organized, and through correspondence with car manufacturers has obtained their engineering specifications on toe-in, camber, caster and king-pin inclination. Contact has been made with the principal foreign automobile manufacturers, and the Subcommittee has been assured of their cooperation in securing data on foreign cars. A report at the present Annual Meeting embodies the findings on the adaptability of various instruments available to measure the elements that control wheel alignment. This survey is preliminary to the tests to be conducted at the General Motors Proving Ground by O. T. Kreusser, checking the toe-in, camber, caster and king-pin inclination of new cars against data recorded after the cars have had several thousand miles of service.

Mechanical Springs

The Special Research Committee on Mechanical Springs, of the American Society of Mechanical Engineers, with which this Society is cooperating, submitted a Progress Report at the annual meeting of the A.S.M.E. The report is in the form of a paper by M. F. Sayre and A. Hoadley, and covers the first year of investigations carried on by the Committee at Union College to examine the fundamental characteristics of spring action to determine more reliable constants for a code of design.

Dr. McAdam, of the Naval Engineering Experiment Station at Annapolis, also reported on the investigation being conducted for the Committee under his direction. The tests are covered in a paper on The Fatigue and Corrosion-Fatigue of Spring Material. A very interesting paper by A. M. Wahl, on Stresses in Heavy Closely Coiled Helical Springs, was sponsored by the Committee.

Research Department

In addition to assisting in carrying on the research projects of the Society, the Research Department has maintained its contacts with college research groups and industrial laboratories and has made the results of these contacts available through the Automotive Research Department of the S.A.E. JOURNAL and in Notes and Reviews. To facilitate the Department's technical information service, additional library equipment has been installed and the information files enlarged during 1928.

H. C. DICKINSON,
Chairman.

Sections Committee Report

Several important problems which have faced the Sections Committee during the year will be carried over into the 1929 administrative year.

Foremost is the problem of Section dues, the Committee recommendation having been tabled by the Council. The Sections Committee believes that the Section activity of the Society is of such a nature that the Section dues should be included with the Society dues, one charge of $20 being made as Society dues, the Sections being credited with a certain percentage of the dues of each member within Section territory.

The question was raised first at the January, 1928, meeting of the Sections Committee, the motion made at that time being that as soon as practical all members be billed $20 in one sum to cover both Society and Section dues, it being understood that all members would be supplied with

INCREASE IN SECTION MEMBERS

Year	Number of Members
1928	3,616
1927	3,209
1926	2,819
1925	2,329[a]
1924	1,229

[a] Section dues were billed by the Society beginning in 1925.

MEMBERSHIP STANDING OF THE SECTIONS AS OF OCT. 1, 1928

Section	Number of S.A.E. Members in Section Territory	Number of Section Members	Percentage of Section to Society Members in Territory 1928	1927	Gain or Loss, Per Cent
New England	125	147	118	108	+12
Buffalo	99	115	116	135	—19
Indiana	113	129	114	106	+12
Pennsylvania	221	239	108	98	+10
Detroit	1018	983	97	83	+14
Dayton	85	78	92	43	+49
Metropolitan	1093	931	85	80	+ 5
Milwaukee	137	114	83	78	+ 5
Cleveland	379	308	81	75	+ 6
S. California	136	107	79	77	+ 2
Chicago	396	298	75	75	+ 0
Washington	95	70	74	64	+10
N. California	137	97	71	65	+ 6
Totals	4034	3616	84	81	+ 3

SECTION MEMBERSHIP AND FINANCES, OCT. 1, 1927, TO OCT. 1, 1928

Section	Section Membership Oct. 1, 1928	Percentage of Section to Society Members in Territory	Section Dues	Section Appropriations	Section Appropriations per Member	Total Section Expense[1]	Total Section Expense per Member	Section Papers Published in the S.A.E. JOURNAL
Detroit	983	97	$4,737.50	$4,217.00	$4.29	$8,399.25	$8.54	9
Metropolitan	931	85	4,565.00	——	——	3,720.60	4.00	2
Cleveland	308	81	1,527.50	——	——	3,208.09	10.42	3
Chicago	298	75	1,495.00	——	——	1,684.75	5.65	4
Pennsylvania	239	108	1,107.50	——	——	1,120.99	4.69	2
New England	147	118	725.00	——	——	917.06	6.24	5
Indiana	129	114	690.00	300.00	2.33	1,059.94	8.22	4
Buffalo	115	116	585.00	187.00	1.63	729.55	6.34	2
Milwaukee	114	83	562.50	330.00	2.89	1,084.55	9.51	1
Southern California	107	79	470.00	175.00	1.64	431.79	4.04	2
Northern California	97	71	452.50	——	——	508.76	5.24	0
Dayton	78	92	375.00	——	——	526.14	6.75	1
Washington	70	74	380.00	163.50	2.34	316.08	4.52	1

[1] Section income from dinners deducted.

copies of papers given at the meetings of the Section nearest to which each lives. The cost of distributing the Section papers in this way was found to be prohibitive, as only about 22 per cent of the Section papers are printed in The Journal; therefore the Council referred the matter back to the Sections Committee with a statement to this effect.

At the June meeting of the Sections Committee, the matter was considered at great length, and the following resolution was unanimously submitted to the Council:

> Whereas, the Sections Committee believes that Sections constitute one of the most important activities of the Society and, whereas, all members in the United States, regardless of residence, share equally in the benefits derived from Section activities, both through meetings and papers published in The Journal, and, whereas, we believe that segregation of dues for National and Section membership is an inequitable means of supporting Society activities, therefore,
>
> *Be It Resolved*, that this Committee recommends to the Council that the necessary steps be taken to make the Society and Sections dues one charge of $20 against each member in the United States, $5 of this to be made available to the nearest Section, if needed.

In taking no action on this resolution the Council apparently feels that the increase in dues would work a hardship on non-Section members who live outside of Section territory. The subject of Section dues will be discussed again at the meeting of the Sections Committee to be held on the first day of the 1929 Annual Meeting, and it is hoped that a supplementary report may be adopted at this meeting and submitted at the Business Session.

Section Entertainment Expense

Another matter that has been discussed at considerable length by the Committee is entertainment at Section meetings. The following resolution, adopted at the June meeting of the Committee, is awaiting further consideration:

> The Sections Committee recommends to the Council that a reasonable entertainment expense be recognized on the same basis as other legitimate expenses, such as printing and a limited number of complimentary dinner tickets, and that Sections be allowed an expense of 25 cents per person attending a Section dinner, not to exceed a maximum of $150 at any one meeting.

To simplify the work of the Section officers and committee members as much as possible, a Section Manual or Guide has been issued listing the main points of contact between the National and the Section organizations. Copies of these manuals have been supplied to all Section officers and Chairmen of the various committees. It is believed that the change in billing of Society and Section dues proposed would simplify the work of the Section officers a great deal, as a check of the Section Manual indicates that approximately 33 paragraphs are required by the present method of collecting Section dues, and in addition the Membership Committees of the Sections could better assist the Society Membership Committee in securing Society members.

Another matter which the Sections Committee will consider at the Jan. 15 meeting, and on which a supplementary report will be submitted, is the organization of a Student Branch Committee.

Section Membership Activity

As a result of joint discussions with the Membership Committee, a comprehensive National membership campaign has been undertaken in which the Section officers and the Section Membership Committees play an important part, it being recognized that the benefits to be derived from attendance at Section meetings should be emphasized in Society membership activities. The Metropolitan and Detroit Sections have led the way in this membership work, and the Society membership procedure that has been approved as a result of the joint Section and Membership Committee activity is an outgrowth of the work of these two Sections.

Canadian and Northwest Sections Recognized

The Sections Committee is pleased to announce that two probationary Sections have been recognized: the Canadian Section, with headquarters in Toronto, and the Northwest Section, with headquarters in Seattle. Both Sections, in accordance with the Sections regulations, will be probationary Sections for one year, at the end of which time they will be recognized as official Sections. They will operate, however, in every particular as do the other Sections, their notices and reports of meetings being printed in the S. A. E. Journal.

Aeronautic and Body Divisions Formed

Aeronautic Divisions have been organized during the year in the Detroit, New York and Chicago Sections, and a Body Division was organized in the Detroit Section. There is also evidence that additional Divisions will be formed in the near future. Mention should be made of the success of the Divisional idea in Detroit, where Division meetings are now attracting as many members as regular meetings of the Section.

Complete statements of the membership, paid-up Section members during recent years, and finances of the Sections for the last administrative year of the Sections are given in the tables on the opposite page.

Vincent Apple,
Chairman.

Standards Committee Report

At the close of 1928 the Standards Committee can again report substantial progress during the last administrative year. Although the pressure of their business on many members of the Standards Committee has made some of the work progress more slowly than might be hoped for, the general work of the Committee has gone ahead steadily and effectively. Realization of the value of standardization to industry has continued to grow throughout the year and new efforts have beeen extended within the Society's Standards Committee as well as its many outside contacts in the standardization work. Related research activity, such as the automobile headlighting program under the Research Department of the Society, has been continued, looking toward the adoption of new and more valuable standards.

Organization

The Standards Committee consisted of 22 regular Divisions, as during the previous year, most of the Divisions having been relatively active. The preliminary work of the Standards Committee during the year was done by more than 60 Subdivisions of the various Divisions. The total number of members of all the Divisions of the Standards Committee is 255, or an average of 11 members per Division.

The special Committees on Methods of Expressing Limits and Tolerances, on Patents, and on Standardization Policy were continued as in 1927, but no cooperating Committees were organized during the year, as subjects that might have been considered in conjunction with standardization activities were taken care of by the regular Divisions of the Standards Committee.

Meetings

During the year, 18 Division and 21 Subdivision meetings were held, as a result of which recommendation for 29 new standards and recommended practices, the revising

of 28 existing standards, and the cancelling of 15 of the Society's specifications, have been submitted to the Standards Committee and the Society. Also, one report of a Sectional Committee has been approved by the Society as a sponsor. At the close of the year, 80 subjects were under active consideration by the Standards Committee.

Following the Standards Committee meeting in June, 1928, letter-ballots for approval of standards reports were mailed to 3037 members, in response to which 457 ballots were returned, 5 of which were unsigned. The only subject reported during the year that was withheld from publication following the letter-ballots was that on **Aeronautical Instrument Mountings.**

Probably the outstanding development in the Society's standardization activities was in aeronautics. The Aeronautical Division was very active throughout the year and held three largely attended aeronautical standardization sessions, in Detroit in April, in Los Angeles in September, and in Chicago in December.

S.A.E. Handbook

The 1928 issue of the S.A.E. HANDBOOK was mailed to the members early in April. The complete HANDBOOK was not reprinted following the adoption of standards at the Summer Meeting of the Society, in accordance with previous direction by the Council to print the complete HANDBOOK but once a year. The reports adopted and the 36 reports approved at the Summer Meeting were printed in the Supplement to the HANDBOOK issued to the members in September. These specifications, if not revised or cancelled, will be incorporated in the 1929 issue of the HANDBOOK following this Annual Meeting of the Society. The manufacturers' listing is growing steadily, about 875 companies being listed in the 1928 HANDBOOK, an increase of approximately 150 over the previous year. It is anticipated that more than 100 additional companies will be listed in the 1929 issue as sources of articles and materials fabricated in accordance with S.A.E. specifications.

Standards Surveys

Surveys of the extent to which the S.A.E. Standards are used and to determine whether they require reconsideration as to revision or cancellation have been continued during the year. These surveys are very useful to the Divisions of the Standards Committee in their current work.

Sectional Committees

The Society has continued to sponsor the Sectional Committees for which it was sponsor during the previous year. It has also named representatives on the following Sectional Committees during the year: Shafting, Motor-Frame Dimensions, Speeds of Driven Machines.

American Standards Association

The American Standards Association succeeded the American Engineering Standards Committee on Nov. 1 by action of the member-bodies, of which the Society is one. The principal changes in the organization were in name and in control function. The business administration of the A.S.A. is by a Board of Directors, the members of which it is planned shall be men, of the executive type, of broad experience. Matters relating to standardization are governed by the Standards Council. The Society is to be represented on the Board of Directors, as well as on the Standards Council. The major change in the prescribed procedure was to authorize the organizing of autonomous Sectional Committees, whereas previously Sectional Committees were always sponsored. The work in general under the procedure of the A.S.A. has expanded rapidly during the year. The Society is carrying its share of these activities.

Mechanical Standards Advisory Council

With the growth during the last few years of standardization on a National basis relating to all major industries, many problems arose that were frequently difficult to solve. The standardization activities under the American Standards Association can be classed generally as relating to the mechanical and the electrical industries and to safety codes. It was felt that an advisory body of some kind, that would be representative of the interests commonly referred to as mechanical, would serve a very useful purpose to the industry as an advisory body in matters relating to standardization and also to the American Standards Association in correlating mechanical standardization, serving as an impartial court of appeals in cases of dispute, and otherwise as occasion might require. This body will not formulate standards but will endeavor to bring inter-industrial standardization under the procedure of the A.S.A. The Society is directly connected with this undertaking, which was definitely established in October, by representation on the Executive Committee of the Mechanical Standards Advisory Council, in company with representatives of six other National societies and associations.

International Standardization

This work, as reported last year, has progressed slowly, although no new projects in which the Society is directly concerned have been undertaken during the year internationally.

General Interests

The Society has maintained its representation on such Committees other than its own as were reported last year. Many of these Committees have made appreciable progress during the last year. The results of their work will be of value in the general standardization activities.

H. M. CRANE,
Chairman.

Treasurer's Report

This copy of the Comparative Balance Sheet and Income and Expense Comparison is distributed to the members so that they may see the exact condition of the Society's finances.

The income for the year is $12,939.58 less than for 1927, and $14,245.80 less than the budget, due principally to a falling off of revenue from advertising. Such falling off we anticipate will be prevented in 1929 by the increase of 20 per cent in the advertising rates, which has not been accompanied by any marked decrease in the number of contracts for the ensuing year. The Society's expenses have increased $13,933.28 over 1927, which is natural with the growth of the Society and the keeping up of the high standard of its activities. In spite of a decrease in revenue and an increase in expenditure, we had $4,599.64 unexpended income for the last fiscal year, and an increase of $13,418.37 in securities deposited with the Chemical National Bank of New York, all of which gives us the assurance that we hold an enviable position financially.

The Finance Committee and your Council have approved a Budget for 1929 of $395,000.00, an increase of $14,000.00 over 1928, which we believe can be maintained by increased efforts.

I cannot close without mentioning your very loyal and efficient office staff under the direction of our dear and untiring Coker Clarkson, for they all help to bring about these results.

ADVISORY BOARD ON DICTIONARY OF GOVERNMENT SPECIFICATIONS

C. F. Clarkson	Society of Automotive Engineers, Inc.
R. S. Burnett (*Alternate*)	Society of Automotive Engineers, Inc.

POWERPLANT SUBCOMMITTEE OF NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

H. M. Crane	General Motors Corp.

HIGHWAY RESEARCH BOARD OF THE NATIONAL RESEARCH COUNCIL

B. B. Bachman	Autocar Co.
H. M. Crane (*Alternate*)	General Motors Corp.

ENGINEERING DIVISION OF THE NATIONAL RESEARCH COUNCIL

J. H. Hunt	General Motors Corp.
C. B. Veal	Society of Automotive Engineers, Inc.

ADVISORY BOARD OF GOVERNMENT TECHNICAL COMMITTEE ON LUBRICANTS AND LIQUID FUELS

C. F. Kettering	General Motors Corp. Research Laboratories

COMMITTEE ON MOTORCOACHES OF THE AMERICAN ELECTRIC RAILWAY ASSOCIATION

S. W. Mills	Pierce Arrow Motor Car Co.
L. H. Palmer	Fifth Avenue Coach Co.
A. J. Scaife	White Motor Co.

SUBCOMMITTEE D-11 ON RUBBER PRODUCTS OF THE A.S.T.M.

L. C. Conradi	Spicer Mfg. Corp.

SUBCOMMITTEE XII ON METHODS OF CHEMICAL ANALYSIS OF COMMITTEE A-1 ON STEELS OF THE A.S.T.M.

J. R. Adams	Midvale Co.

SUBCOMMITTEE XV ON DIE-CASTING METALS AND ALLOYS OF COMMITTEE B-2 OF THE A.S.T.M.

C. W. Simpson	White Motor Co.

COMMITTEE A-7 ON MALLEABLE IRON OF THE A.S.T.M.

H. T. Chandler	Vanadium Corp. of America

SUBCOMMITTEE XIX ON SHEET STEEL OF COMMITTEE A-1 ON STEELS OF THE A.S.T.M.

W. C. Peterson	Donner Steel Co.

NATIONAL SCREW-THREAD COMMISSION

Earle Buckingham	Massachusetts Institute of Technology
George S. Case	Lamson & Sessions Co.

COMMITTEE D-2 ON OILS OF THE A.S.T.M.

H. C. Mougey	General Motors Corp. Research Laboratories

COMMITTEE ON FORM AND ARRANGEMENT OF SPECIFICATIONS OF THE AMERICAN STANDARDS ASSOCIATION

R. S. Burnett	Society of Automotive Engineers, Inc.

SUBCOMMITTEE XIV ON TOOL STEEL OF COMMITTEE A-1 ON STEELS OF THE A.S.T.M.

A. H. d'Arcambal	Pratt & Whitney Co.

A.S.T.M.—A.S.S.T.—S.A.E. JOINT COMMITTEE ON DEFINITIONS FOR HEAT-TREATMENT OF STEEL

J. A. Matthews	Crucible Steel Co. of America
G. L. Norris	Vanadium Corp. of America
S. P. Rockwell	Stanley P. Rockwell Co.

FEDERAL SPECIFICATIONS BOARD COMMITTEE ON STORAGE BATTERIES

F. H. Prescott	Delco-Remy Corp.

MECHANICAL STANDARDS ADVISORY COUNCIL

K. J. Ammerman	American Car & Foundry Motors Co.

Larger Airplanes an Economic Need

THE trend of the human mind is to deny as impractical that which has not yet been accomplished, so the pioneers of an industry have literally to fight for every inch they move forward. It usually requires generations to put into general use what the inventor has made possible. The man without vision, the man who stands still in his tracks, prefers to call himself conservative and often alludes to the pioneer as impractical. But who is the more impractical, the pioneer who points out the newer and better methods, or the so-called conservative who denies that the newer methods are possible?

It is no more difficult to build a 100-passenger airplane today than it was to build an 18-passenger airplane in 1919; but it is just as difficult to make others understand that a 100-passenger plane can be built today as it was to make them understand that I could build an 18-passenger plane 10 years ago.

The 100-passenger airplane is more economical than the 18-passenger plane, just as the 18-passenger plane is more economical than the two-passenger plane. Furthermore, the 200-passenger airplane will be more economical than the 100-passenger plane.

As the size of the double passenger-tier plane is increased, the horsepower and the total load per passenger is decreased, so the larger airplanes decrease the cost of operation per passenger; therefore, the fares can be reduced. The operation of 100-passenger double-tier planes makes possible the cutting of passenger fares on airliners below those charged by railroads. Larger passenger-airplanes therefore are necessary to solve the problem of the cost of operation per passenger.

There is no more reason to expect that a 10-passenger plane can be operated at a low cost per passenger than there would be to expect that a 10-passenger train could be operated at a low cost per passenger.

In due time old Father Economics will force even the most conservative to recognize the necessity for the large double-tier passenger airliner, with its cheap passenger-fares. And when that time comes, the masses will take to air travel as they now take to railroad travel.

The people who deny that these things can be accomplished are the impractical ones. The airplane industry will go just as far ahead as its pioneers are capable of seeing. The financiers, however, must furnish the motive power to get there.—From address by Alfred W. Lawson, at the International Civil Aeronautics Conference.

E. N. Sawyer	Cleveland Tractor Co.
C. W. Spicer	Spicer Mfg. Corp.

STANDARDIZATION OF ELECTRIC MOTOR FRAME DIMENSIONS[2]

R. S. Burnett (*Interim*)	Society of Automotive Engineers, Inc.

TRANSMISSION CHAINS AND SPROCKETS[1]

W. J. Belcher	Whitney Mfg. Co.
W. F. Cole	Baldwin Chain & Mfg. Co.
M. C. Horine	International Motor Co.
G. A. Young	Purdue University
O. B. Zimmerman	International Harvester Co.

USE, CARE AND PROTECTION OF ABRASIVE WHEELS[2]

A. J. Gifford	Leland-Gifford Co.

WIRE AND SHEET-METAL GAGING SYSTEMS[1]

W. H. Hutchins	North East Electric Co.
B. M. Leece	Leece-Neville Co.
W. J. Outcalt	General Motors Corp.
F. G. Whittington	Stewart-Warner Speedometer Corp.

ZINC COATING OF IRON AND STEEL[2]

W. H. Hutchins	North East Electric Co.
W. M. Phillips	General Motors Corp.
W. B. Stout	W. B. Stout Engineering & Finance Co.

SPECIAL COMMITTEES AND COOPERATING BODIES ON WHICH THE SOCIETY IS REPRESENTED

ORDNANCE ADVISORY COMMITTEE

A. F. Masury, *Chairman*	International Motor Co.
H. W. Alden	Timken-Detroit Axle Co.
George A. Green	Yellow Truck & Coach Mfg. Co.
F. C. Hecox	Cadillac Motor Car Co.
A. W. Herrington	Coleman Motors Corp.
P. E. Holt	Caterpillar Tractor Co.
E. F. Norelius	Monarch Tractors Corp.
G. A. Round	Vacuum Oil Co.
W. G. Wall	Indianapolis
J. F. Winchester	Standard Oil Co. of N. J.

STOCK CAR CONTEST ADVISORY COMMITTEE

T. J. Lítle, Jr., *Chairman*	Marmon Motor Car Co.
F. S. Duesenberg	Duesenberg, Inc.
A. W. Herrington	Coleman Motors Corp.
C. S. Ricker	Waukesha Motor Co.
D. G. Roos	Studebaker Corp.
H. C. Snow	Auburn Automobile Co.
W. G. Wall	Indianapolis
L. M. Woolson	Packard Motor Car Co.

COOPERATIVE FUEL RESEARCH STEERING COMMITTEE

(Cooperating with the National Automobile Chamber of Commerce and the American Petroleum Institute)

B. B. Bachman	Autocar Co.
O. C. Berry	Borg-Warner Corp.
T. A. Boyd	General Motors Corp. Research Laboratories
H. R. Cobleigh	National Automobile Chamber of Commerce
H. M. Crane	General Motors Corp.
H. C. Dickinson	Bureau of Standards
H. L. Horning	Waukesha Motor Co.
W. S. James	Studebaker Corp.
C. S. Kegerreis	Tillotson Mfg. Co.
C. F. Kettering	General Motors Corp. Research Laboratories
J. B. Macauley	Chrysler Motors
F. C. Mock	Stromberg Motor Devices Co.
S. W. Sparrow	Studebaker Corp.
J. F. Winchester	Standard Oil Co. of New Jersey

COOPERATIVE COMMITTEE OF BUREAU OF PUBLIC ROADS ON MOTOR-TRUCK IMPACT TESTS

B. B. Bachman	Autocar Co.
Benjamin Liebowitz	New York City
C. B. Veal	Society of Automotive Engineers, Inc.

SPECIAL RESEARCH COMMITTEE ON MECHANICAL SPRINGS OF THE A.S.M.E.

N. E. Hendrickson	Mather Spring Co.
Benjamin Liebowitz	New York City
E. W. Stewart	William D. Gibson Co.

EXECUTIVE BOARD OF AMERICAN AUTOMOBILE ASSOCIATION

R. S. Begg	Budd Wheel Co.

AMERICAN BUREAU OF WELDING

Alexander Churchward	Wilson Welder & Metals Co., Inc.

AMERICAN STANDARDS ASSOCIATION

STANDARDS COUNCIL

C. F. Clarkson	Society of Automotive Engineers, Inc.
A. J. Scaife	White Motor Co.
C. B. Veal	Society of Automotive Engineers, Inc.
Alternates	
R. S. Burnett	Society of Automotive Engineers, Inc.
H. M. Crane	General Motors Corp.
K. L. Herrmann	Studebaker Corp.

BOARD OF DIRECTORS

F. E. Moskovics	Indianapolis

AMERICAN MARINE STANDARDS COMMITTEE OF DIVISION OF SIMPLIFIED PRACTICE

R. S. Burnett	Society of Automotive Engineers, Inc.
Henry R. Sutphen	Submarine Boat Corp.

COMMITTEE A-1 ON STEELS OF THE A.S.T.M. AND ITS SUBCOMMITTEE X ON AUTOMOBILE STEELS

F. P. Gilligan	Henry Souther Engineering Corp.

JOINT COMMITTEE ON INVESTIGATION OF PHOSPHORUS AND SULPHUR IN STEEL OF THE A.S.T.M.

F. P. Gilligan	Henry Souther Engineering Corp.

ADVISORY COMMITTEE ON STRUCTURES AND FABRICATED METALS OF THE BUREAU OF STANDARDS

C. L. Burns	American Machine & Foundry Co.
J. H. Nelson	Wyman-Gordon Co.

COMMITTEE ON FERROUS METALS OF THE BUREAU OF STANDARDS

F. P. Gilligan	Henry Souther Engineering Corp.
W. C. Peterson	Donner Steel Co.

JOINT ARMY AND NAVY AERONAUTIC CONFERENCE

E. T. Jones	Wright Aeronautical Corp.
Edward Wallace	Great Lakes Aircraft Corp,

[1] Sponsored by the Society.

[2] The Society does not sponsor but is represented on this Sectional Committee.

Eugene Power, *Western Vice-Chairman*	Union Oil Co. of California
W. F. Banks	Motor Haulage Co., Inc.
Donald Blanchard	Chilton Class Journal Co.
Henry Dakin	Michigan Bell Telephone Co.
William J. Duffy	Big 3, Inc.
H. F. Fritch	Boston & Maine Railroad
E. Favary	Moreland Motor Truck Co.
F. K. Glynn	American Telephone & Telegraph Co.
E. H. Grey	Gulf Refining Co.
F. W. Herlihy	United Electric Railway Co.
A. M. Hill	Blue & Gray Transportation Co.
George Hook	Chilton Class Journal Co.
C. C. Humber	Longview Co.
H. W. Kizer	Texas Co.
Charles S. Lyon	Motor Haulage Co., Inc.
A. F. Masury	International Motor Co.
A. S. McArthur	Toronto Transportation Commission
E. D. Merrill	Washington Rapid Transit Co.
H. V. Middleworth	Consolidated Gas Co.
L. V. Newton	Byllesby Engineering Management Corp.
E. S. Pardoe	Capital Traction Co.
G. I. Pooley	Chesapeake & Potomac Telephone Co. and Associated Companies
T. L. Preble	Brockway Motor Truck Corp.
B. K. Rhoads	American Railway Express Co., Inc.
A. J. Scaife	White Motor Co.
F. J. Scarr	Scarr Transportation Service
Pierre Schon	General Motors Truck Co.
S. B. Shaw	Pacific Gas & Electric Co.
P. V. C. See	Northern Ohio Power & Light Co.
R. B. Stoeckel	Commissioner of Motor Vehicles, State of Connecticut
E. W. Templin	Mavis Bottling Co. of America
J. F. Winchester	Standard Oil Co. of N. J.
E. C. Wood	Pacific Gas & Electric Co.
G. C. Woodruff	L. C. L. Container Co.

REPRESENTATIVES ON SECTIONAL COMMITTEES

Aeronautical Safety Code[1]

H. M. Crane, *Chairman*	General Motors Corp.
Archibald Black	Garden City, N. Y.
V. E. Clark	Buffalo
E. T. Jones	Wright Aeronautical Corp.
G. L. Martin	Glenn L. Martin Co.
G. J. Mead	Pratt & Whitney Aircraft Co.
I. M. Uppercu	Uppercu-Cadillac Co.
R. H. Upson	Aeromarine-Klemm Corp.
T. P. Wright	Curtiss Aeroplane & Motor Co., Inc.

Ball Bearings[1]

R. S. Burnett, *Secretary*	Society of Automotive Engineers, Inc.
F. L. Brown	White Motor Co.
H. E. Brunner	S. K. F. Industries, Inc.
W. J. Canada	National Electrical Manufacturers Association
D. F. Chambers	Bearings Co. of America
L. A. Cummings	Marlin-Rockwell Corp.
F. W. Gurney	Marlin-Rockwell Corp.
F. G. Hughes	New Departure Mfg. Co.

[1] Sponsored by the Society.

[2] The Society does not sponsor but is represented on this Sectional Committee.

Bolt, Nut and Rivet Proportions[1]

J. A. Anglada	Anglada Motor Corp.
A. Boor	Willys-Overland Co.
A. H. Gilbert	Rock Island Plow Co.
M. C. Horine	International Motor Co.
W. J. Outcault	General Motors Corp.

Brakes and Brake Testing[2]

J. R. Cautley	Bendix Brake Co.
R. E. Fielder	Yellow Mfg. Sales Corp.

Drawings and Drafting Room Practice[2]

M. C. Frins	International Motor Co.
C. F. Drumm (*Alternate*)	International Motor Co.

Gears[2]

Earle Buckingham	Massachusetts Institute of Technology
P. L. Tenney	Muncie Products Division, General Motors Corp.

Insulated Wire and Cable[2]

F. W. Andrew	Mitchell Specialty Co.
W. S. Haggott	Packard Electric Co.

Machine-Tool Safety-Code[2]

A. J. Gifford	Leland-Gifford Co.

Motor Vehicle Lighting Specifications[1]

H. M. Crane	General Motors Corp.
T. J. Litle, Jr.	Marmon Motor Car Co.
C. A. Michel	Guide Lamp Corp.
A. J. Scaife	White Motor Co.
P. V. C. See	Northern Ohio Power & Light Co.

Pins and Washers[1]

W. J. Outcalt	General Motors Corp.
O. B. Zimmerman	International Harvester Co.

Pipe Threads[2]

Joseph Berge	Crowner Co.

Plain Limit-Gages and Gaging Systems[2]

P. W. Abbott	Studebaker Corp.
D. W. Ovaitt	Buick Motor Co.

Scientific and Engineering Symbols and Abbreviations[2]

R. M. Anderson	Stevens Institute of Technology
E. P. Warner (*Alternate*)	Assistant Secretary of the Navy for Aeronautics

Screw-Threads[1]

P. W. Abbott	Studebaker Corp.
A. Boor	Willys-Overland Co.
Earle Buckingham	Massachusetts Institute of Technology
G. S. Case	Lamson & Sessions Co.
E. H. Ehrman	Standard Screw Co.
O. B. Zimmerman	International Harvester Co.

Shafting[2]

C. W. Spicer	Spicer Mfg. Corp.

Subcommittee on Woodruff Keys

K. L. Herrmann	Studebaker Corp.
D. W. Ovaitt	General Motors Corp.
C. W. Spicer	Spicer Mfg. Corp.

Small Tools and Machine-Tool Elements[1]

J. A. Anglada	Anglada Motor Corp.
Earle Buckingham	Massachusetts Institute of Technology
D. W. Ovaitt	Buick Motor Co.

PASSENGER-CAR DIVISION

G. L. McCain, *Chairman*	Chrysler Motors
H. C. Snow, *Vice-Chairman*	Auburn Automobile Co.
S. R. Castor	H. H. Franklin Mfg. Co.
L. A. Chaminade	Studebaker Corp.
W. N. Davis	Cadillac Motor Car Co.
G. A. Delaney	Graham-Paige Motors Corp.
W. T. Fishleigh	Ford Motor Co.
W. H. Graves	Packard Motor Car Co.
J. B. Judkins	J. B. Judkins Co.
E. H. Nollau	E. I. duPont deNemours & Co.
Ivan Ornberg	Hupp Motor Car Corp.

PRODUCTION DIVISION

F. W. Stein, *Chairman*	Fairbanks, Morse & Co.
A. R. Fors, *Vice-Chairman*	Continental Motors Corp.
David Ayr	Pratt & Whitney Co.
F. Barnes	Hupp Motor Car Corp.
F. C. Kroeger	Delco-Remy Corp.
R. R. Lundy	Studebaker Corp.
W. P. Michell	International Motor Co.
D. W. Ovaitt	Buick Motor Co.
L. L. Roberts	Packard Motor Car Co.
E. N. Sawyer	Cleveland Tractor Co.

SCREW THREADS DIVISION

E. H. Ehrman, *Chairman*	Standard Screw Co.
K. L. Herrmann, *Vice-Chairman*	Studebaker Corp.
A. Boor	Willys-Overland Co.
E. J. Bryant	Greenfield Tap & Die Corp.
Earle Buckingham	Massachusetts Institute of Technology
Ellwood Burdsall	Russell, Burdsall & Ward Bolt & Nut Co.
L. D. Burlingame	Brown & Sharpe Mfg. Co.
G. S. Case	Lamson & Sessions Co.
R. M. Heames	Victor Peninsular Co. Division, Allied Products Corp.
J. K. Olsen	Stewart-Warner Speedometer Corp.
D. W. Ovaitt	Buick Motor Co.
O. B. Zimmerman	International Harvester Co.

TIRE AND RIM DIVISION

H. M. Crane, *Chairman*	General Motors Corp.
T. J. Lítle, Jr. *Vice-Chairman*	Marmon Motor Car Co.
C. S. Ash	Wire Wheel Corp. of America
R. S. Begg	Budd Wheel Co.
C. Breer	Chrysler Sales Corp.
C. C. Carlton	Motor Wheel Corp.
B. Darrow	Goodyear Tire & Rubber Co.
E. E. Dearth	Fisk Rubber Co.
W. T. Fishleigh	Ford Motor Co.
A. G. Geistert	Chevrolet Motor Co.
T. G. Graham	B. F. Goodrich Co.
W. R. Griswold	Packard Motor Car Co.
J. E. Hale	Firestone Tire & Rubber Co.
K. L. Herrmann	Studebaker Corp.
H. W. Kranz	Cleveland Welding Co.
B. J. Lemon	United States Rubber Co.
E. S. Marks	H. H. Franklin Mfg. Co.
W. B. Minch	Jaxon Steel Products Division, General Motors Corp.
Maurice Olley	Rolls-Royce of America, Inc.
G. E. Parker	Cadillac Motor Car Co.
A. J. Scaife	White Motor Co.
J. G. Swain	Firestone Steel Products Co.
C. P. Thomas	Reo Motor Car Co.
L. Thoms	Graham-Paige Motors Corp.
F. E. Watts	Hupp Motor Car Corp.

TRANSMISSION DIVISION

P. L. Tenney, *Chairman*	Muncie Products Division, General Motors Corp.
D. E. Gamble, *Vice-Chairman*	Borg & Beck Co.
W. J. Baumgartner	Relay Motors Corp.
A. C. Bryan	Durston Gear Corp.
E. R. Fish	Brown-Lipe Gear Co.
K. L. Herrmann	Studebaker Corp.
B. S. Pfeiffer	Magee-Pfeiffer Co.
D. Sicklesteel	Detroit Gear & Machine Co.
H. W. Sweet	Chrysler Motors
C. E. Swenson	Mechanics Universal Joint Co.
S. O. White	Warner Gear Co.

SPECIAL COMMITTEES

METHODS OF EXPRESSING LIMITS AND TOLERANCES

Earle Buckingham, *Chairman*	Massachusetts Institute of Technology
G. S. Case	Lamson & Sessions Co.
E. H. Ehrman	Standard Screw Co.

PATENTS

B. B. Bachman, *Chairman*	Autocar Co.
Lloyd Blackmore	General Motors Corp.
R. A. Brannigan	National Automobile Chamber of Commerce
Ralph G. Lockwood	Lockwood, Lockwood, Goldsmith & Galt

STANDARDIZATION POLICY

W. G. Wall, *Chairman*	Indianapolis
H. M. Crane	General Motors Corp.
K. L. Herrmann	Studebaker Corp.
J. H. Hunt	General Motors Corp.
T. J. Lítle, Jr.	Marmon Motor Car Co.
A. J. Scaife	White Motor Co.
W. R. Strickland	Cadillac Motor Car Co.

PROFESSIONAL ACTIVITIES COMMITTEES

PRODUCTION COMMITTEE

E. P. Blanchard, *Chairman*	Bullard Machine Tool Co.
J. B. Armitage	Kearney & Trecker Corp.
L. A. Baron	Stutz Motor Car Co. of America, Inc.
Wm. Bayes	White Motor Co.
G. W. Blackinton	Continental Motors Corp.
P. A. Brown	Graham-Paige Motor Corp.
L. A. Churgay	Chrysler Motors
F. H. Colvin	*American Machinist*
Harry Ford	Cadillac Motor Car Co.
A. R. Fors	Continental Motors Corp.
G. W. Gilmer, Jr.	Detroit
Guy Hubbard	National Acme Co.
J. H. Knapp	Detroit Gear & Machine Co.
J. C. Mottashed	Hudson Motor Car Co.
W. W. Nichols	D. P. Brown & Co.
Erik Oberg	*Machinery*
W. J. O'Neil	Chrysler Motors
N. H. Preble	Mechanical Handling Systems, Inc.
L. L. Roberts	Packard Motor Car Co.
V. P. Rumely	Hudson Motor Car Co.
E. N. Sawyer	Cleveland Tractor Co.
F. W. Stein	Fairbanks, Morse & Co.
E. W. Weaver	Trundle Engineering Co.
John Younger	Ohio State University

TRANSPORTATION COMMITTEE

F. C. Horner, *Chairman*	General Motors Corp.
W. M. Clark, *Eastern Vice-Chairman*	S. S. Pierce Co.
H. L. Debbink, *Mid-West Vice-Chairman*	Milwaukee Electric Railway & Light Co.

IRON AND STEEL DIVISION

J. M. Watson, *Chairman*	Hupp Motor Car Corp.
A. H. d'Arcambal *Vice-Chairman*	Pratt & Whitney Co.
J. R. Adams	Midvale Co.
R. J. Allen	Rolls-Royce of America, Inc.
A. L. Boegehold	General Motors Corp. Research Laboratories
Henry Chandler	Vanadium Corp. of America
J. D. Cutter	Fafnir Bearing Co.
B. H. DeLong	Carpenter Steel Co.
F. P. Gilligan	Henry Souther Engrg. Corp.
H. W. Graham	Jones & Laughlin Steel Corp.
H. L. Greene	Willys-Overland Co.
E. J. Janitzky	Illinois Steel Co.
J. A. Mathews	Crucible Steel Co. of America
W. C. Peterson	Donner Steel Co.
E. A. Portz	Central Alloy Steel Corp.
S. P. Rockwell	Stanley P. Rockwell Co.
R. B. Schenck	Buick Motor Co.
W. R. Shimer	Bethlehem Steel Co.
Ralph R. Teetor	Perfect Circle Co.
H. P. Tiemann	Carnegie Steel Co.
E. W. Upham	Chrysler Motors
T. H. Wickenden	International Nickel Co.
O. B. Zimmerman	International Harvester Co.

LIGHTING DIVISION

C. A. Michel, *Chairman*	Guide Lamp Corp.
R. N. Falge, *Vice-Chairman*	General Motors Corp. Research Laboratories
Clyde C. Bohner	Tung-Sol Lamp Works
H. S. Broadbent	Westinghouse Lamp Co.
R. E. Carlson	Edison Lamp Works of the General Electric Co.
A. W. Devine	Registry of Motor Vehicles, Commonwealth of Massachusetts
H. C. Doane	Buick Motor Co.
G. P. Doll	Corcoran Lamp Co.
R. W. Johnson	John W. Brown Mfg. Co.
W. M. Johnson	National Lamp Works of the General Electric Co.
A. R. Lewellen	Chevrolet Motor Co.
D. M. Pierson	Chrysler Motors
W. F. Thoms	Indiana Lamp Corp.
T. E. Wagar	Studebaker Corp.

LUBRICANTS DIVISION

E. W. Upham, *Chairman*	Chrysler Motors
H. C. Mougey, *Vice-Chairman*	General Motors Corp. Research Laboratories
Sydney Bevin	Tide Water Oil Co.
A. B. Boehm	Standard Oil Co. of New Jersey
O. E. Eckert	Mid-Continent Petroleum Corp.
J. B. Fisher	Waukesha Motor Co.
J. C. Geniesse	Atlantic Refining Co.
W. H. Graves	Packard Motor Car Co.
C. M. Larson	Sinclair Refining Co.
K. G. Mackenzie	Texas Co.
W. H. Oldacre	D. A. Stuart & Co.
W. F. Parish	New York City
G. A. Round	Vacuum Oil Co.
H. J. Saladin	Standard Oil Co. of Indiana
W. A. P. Schorman	British American Oil Co., Ltd.
F. D. Shields	Transcontinental Oil Co.
B. E. Sibley	Continental Oil Co.
C. W. Simpson	White Motor Co.
H. G. Smith	Gulf Refining Co.
J. B. Terry	Standard Oil Co. of California
R. E. Wilson	Standard Oil Co. of Indiana

MOTORBOAT AND MARINE ENGINE DIVISION

Leonard Ochtman, Jr., *Chairman*	Elco Works
C. A. Carlson	Remington Oil Engine, Inc.
N. E. Donnelly	Dawn Boat Corp.
H. E. Fromm	Chrysler Sales Corp.
S. Clyde Kyle	American Car & Foundry Co.
H. R. Sutphen	Submarine Boat Corp.
Joseph Van Blerck	Van Blerck Motors, Inc.

MOTORCOACH DIVISION

A. J. Scaife, *Chairman*	White Motor Co.
S. W. Mills, *Vice-Chairman*	Pierce-Arrow Motor Car Co.
W. F. Klein	General Motors Truck Co.
A. A. Lyman	Public Service Coordinated Transport
L. H. Palmer	Fifth Avenue Coach Co.
A. W. Scarratt	International Harvester Co.
G. R. Scragg	Mack-International Motor-Truck Corp.
P. V. C. See	Northern Ohio Power & Light Co.
F. A. Whitten	McCord Radiator & Mfg. Co.

MOTOR-TRUCK DIVISION

F. A. Whitten, *Chairman*	McCord Radiator & Mfg. Co.
B. B. Bachman, *Vice-Chairman*	Autocar Co.
W. J. Baumgartner	Relay Motors Corp.
Carl J. Bock	General Motors Truck Co.
A. W. Herrington	Coleman Motors Corp.
M. C. Horine	International Motor Co.
S. W. Mills	Pierce-Arrow Motor Car Co.
A. J. Scaife	White Motor Co.
A. W. Scarratt	International Harvester Co.
E. M. Schultheis	Timken Roller Bearing Co.
Ernest M. Sternberg	Sterling Motor Truck Co.

NON-FERROUS METALS DIVISION

Zay Jeffries, *Chairman*	Aluminum Co. of America
C. W. Simpson, *Vice-Chairman*	White Motor Co.
W. H. Bassett	American Brass Co.
C. H. Calkins	Baush Machine Tool Co.
D. L. Colwell	Stewart Die Casting Corp.
H. R. Corse	Lumen Bearing Co.
W. A. Cowan	National Lead Co.
P. V. Faragher	United States Aluminum Co.
W. H. Graves	Packard Motor Car Co.
H. L. Greene	Willys-Overland Co.
J. B. Johnson	Engineering Division, Air Corps
R. R. Moore	Wright Aeronautical Corp.
H. C. Mougey	General Motors Corp. Research Laboratories
A. L. Nelson	Bohn Aluminum & Brass Corp.
W. M. Peirce	New Jersey Zinc Co.
W. B. Price	Scovill Mfg. Co.
T. H. Wickenden	International Nickel Co.
H. M. Williams	Frigidaire Corp.

PARTS AND FITTINGS DIVISION

A. Boor, *Chairman*	Willys-Overland Co.
Ivan Ornberg, *Vice-Chairman*	Hupp Motor Car Corp.
A. K. Brumbaugh	White Motor Co.
R. V. Hutchinson	Olds Motor Works
H. S. Jandus	C. G. Spring & Bumper Co.
W. C. Keys	United States Rubber Co.
G. L. McCain	Chrysler Motors
W. J. Outcalt	General Motors Corp.
C. W. Spicer	Spicer Mfg. Corp.
F. G. Whittington	Stewart-Warner Speedometer Corp.
G. W. Yanss	Eastwood Wire Corp.

B. J. Lemon	United States Rubber Co.
Benjamin Liebowitz	New York City
A. L. Schoff	Overman Cushion Tire Co.
J. A. Sloan	International Motor Co.
J. F. Winchester	Standard Oil Co. of New Jersey

RIDING QUALITIES SUBCOMMITTEE

R. W. Brown, *Chairman*	Firestone Tire & Rubber Co.
F. F. Chandler	Ross Gear & Tool Co.
H. C. Dickinson	Bureau of Standards
Tore Franzen	Chrysler Motors
H. M. Jacklin	Purdue University
Benjamin Liebowitz	New York City
T. J. Litle, Jr.	Marmon Motor Car Co.
Orrel A. Parker	Parker Wheel Co.
W. R. Strickland	Cadillac Motor Car Co.
W. G. Wall	Indianapolis
E. P. Warner	Assistant Secretary of the Navy for Aeronautics
John Warner	Studebaker Corp.

STANDARDS COMMITTEE

A. J. Scaife, *Chairman*	White Motor Co.
A. Boor, *Vice-Chairman*	Willys-Overland Co.
G. L. McCain, *Vice-Chairman*	Chrysler Motors

AGRICULTURAL POWER EQUIPMENT DIVISION

O. B. Zimmerman, *Chairman*	International Harvester Co.
R. O. Hendrickson, *Vice-Chairman*	J. I. Case Threshing Machine Co., Inc.
A. H. Gilbert	Rock Island Plow Co.
P. E. Holt	Caterpillar Tractor Co.
John Mainland	Advance-Rumely Co.
A. C. Rasmussen	Insley Mfg. Co.
O. W. Sjogren	Department of Agricultural Engineering, University of Nebraska
G. A. Young	School of Mechanical Engineering, Purdue University

AIRCRAFT DIVISION

E. P. Warner, *Chairman*	Assistant Secretary of the Navy for Aeronautics
Mac Short, *Vice-Chairman*	Stearman Aircraft Co.
Don M. Alexander	Alexander Aircraft Co.
John R. Cautley	Bendix Brake Co.
J. F. Hardecker	Naval Aircraft Factory
Lieut. C. B. Harper	Bureau of Aeronautics, Navy Department
H. A. Hicks	Stout Metal Airplane Co. Division, Ford Motor Co.
Major C. W. Howard	Materiel Division, Air Corps
I. M. Laddon	Consolidated Aircraft Corp.
K. M. Lane	Wright Aeronautical Corp.
B. J. Lemon	United States Rubber Co.
Ralph G. Lockwood	Fairchild Airplane Mfg. Co.
C. J. McCarthy	Chance Vought Corp.
C. N. Montieth	Boeing Airplane Co.
W. C. Naylor	W. B. Stout Engineering & Finance Co.
C. T. Porter	Keystone Aircraft Corp.
L. D. Seymour	National Air Transport, Inc.
J. G. Swain	Firestone Steel Products Co.
Edward Wallace	Great Lakes Aircraft Corp.
T. P. Wright	Curtiss Aeroplane & Motor Co., Inc.

AIRCRAFT ENGINE DIVISION

L. M. Woolson, *Chairman*	Packard Motor Car Co.
Arthur Nutt, *Vice-Chairman*	Curtiss Aeroplane & Motor Co., Inc.
L. M. Griffith	Emsco Aero Engine Co.
Edward D. Herrick	Lycoming Mfg. Co.
Robert Insley	Continental Motors Corp.
E. T. Jones	Wright Aeronautical Corp.
Bruce G. Leighton	Wright Aeronautical Corp.
Ludwig Majneri	Warner Aircraft Corp.
G. J. Mead	Pratt & Whitney Aircraft Co.
Commander J. M. Shoemaker	Bureau of Aeronautics, Navy Department
Capt. T. E. Tillinghast	Engineering Division, Air Corps
W. L. Velie, Jr.	Velie Motors Corp.

AXLE AND WHEELS DIVISION

O. A. Parker, *Chairman*	Parker Wheel Co.
George Walther, *Vice-Chairman*	Dayton Steel Foundry Co.
B. B. Bachman	Autocar Co.
R. S. Begg	Budd Wheel Co.
L. R. Buckendale	Timken-Detroit Axle Co.
G. W. Carlson	Eaton Axle & Spring Co.
C. C. Carlton	Motor Wheel Corp.
G. W. Harper	Columbia Axle Co.
E. R. Jacobi	Kelsey-Hayes Wheel Corp.
W. F. Rockwell	Wisconsin Parts Co.
F. L. Sage	Graham Bros.

BALL AND ROLLER BEARINGS DIVISION

H. E. Brunner, *Chairman*	S.K.F. Industries, Inc.
G. R. Bott, *Vice-Chairman*	Norma-Hoffmann Bearings Corp.
E. R. Carter, Jr.	Fafnir Bearing Co.
D. F. Chambers	The Bearings Co. of America
L. A. Cummings	Marlin-Rockwell Corp.
T. C. Delaval-Crow	New Departure Mfg. Co.
H. R. Gibbons	Hyatt Roller Bearings Division, General Motors Corp.
B. H. Gilpin	H. H. Franklin Mfg. Co.
G. E. Parker	Cadillac Motor Car Co.
H. N. Parsons	Strom Bearings Co.
Ernest Wooler	Timken Roller Bearing Co.

ELECTRICAL EQUIPMENT DIVISION

A. R. Lewellen, *Chairman*	Chevrolet Motor Co.
D. M. Pierson, *Vice-Chairman*	Chrysler Motors
Azel Ames	Kerite Insulated Wire & Cable Co., Inc.
A. K. Brumbaugh	White Motor Co.
D. S. Cole	Leece-Neville Co.
W. S. Haggott	Packard Electric Co.
L. M. Kanters	Waukesha Motor Co.
T. L. Lee	North East Electric Co.
L. E. Lighton	Electric Storage Battery Co.
L. O. Parker	Delco-Remy Corp.
E. K. Schadt	Cadillac Motor Car Co.
T. E. Wagar	Studebaker Corp.

ENGINE DIVISION

E. S. Marks, *Chairman*	H. H. Franklin Mfg. Co.
A. W. Scarratt, *Vice-Chairman*	International Harvester Co.
Paul Bastien	Stutz Motor Car Co. of America, Inc.
H. C. Blake	Springfield, Ohio
R. J. Broege	Buda Co.
C. L. Cummins	Cummins Engine Co.
J. B. Fisher	Waukesha Motor Co.
J. D. Harris	McCord Radiator & Mfg. Co.
E. D. Herrick	Lycoming Mfg. Co.
Thomas Jackson	Continental Motors Corp.
C. B. Jahnke	Fairbanks, Morse & Co.
E. T. Larkin	Sterling Engine Co.
A. F. Milbrath	Wisconsin Motor Mfg. Co.
L. P. Saunders	Harrison Radiator Corp.
H. G. Smith	Hercules Motors Corp.
V. C. Young	International Motor Co.

1929 Committees of the Society

THERE is listed below the personnel for 1929 of the bulk of the Society Committees, including the technical committees such as the Research and the Standards Committees and their Subcommittees and Divisions; committees auxiliary and subsidiary to these Committees; professional activities committees such as the Production and the Transportation Committees; Sectional Committees, organized under the procedure of the American Standards Association, sponsored by or participated in by the Society; and special committees organized and representatives appointed to cooperate with other civilian and with Governmental organizations.

The personnel of the 1929 Administrative Committees and of the Motor-Vehicle and the Aeronautical Committees, is given in the account in this issue of January Council meetings on p. 246.

TECHNICAL COMMITTEES

RESEARCH COMMITTEE

H. L. Horning, *Chairman*	Waukesha Motor Co.
B. B. Bachman	Autocar Co.
O. C. Berry	Borg-Warner Corp.
R. W. Brown	Firestone Tire & Rubber Co.
F. F. Chandler	Ross Gear & Tool Co.
H. M. Crane	General Motors Corp.
H. C. Dickinson	Bureau of Standards
A. W. Herrington	Coleman Motors Corp.
E. R. Hewitt	International Motor Co.
H. A. Huebotter	Butler Mfg. Co.
J. H. Hunt	General Motors Corp.
H. M. Jacklin	Purdue University
W. S. James	Studebaker Corp.
C. F. Kettering	General Motors Corp.
W. E. Lay	University of Michigan
B. J. Lemon	United States Rubber Co.
Benjamin Liebowitz	New York City
E. H. Lockwood	Yale University
Neil MacCoull	Texas Co.
F. C. Mock	Stromberg Motor Devices Co.
A. L. Nelson	Bohn Aluminum & Brass Corp.
Arthur Nutt	Curtiss Aeroplane & Motor Co., Inc.
V. P. Rumely	Hudson Motor Car Co.
S. W. Sparrow	Studebaker Corp.
W. R. Strickland	Cadillac Motor Car Co.
W. G. Wall	Indianapolis
E. P. Warner	Assistant Secretary of the Navy for Aeronautics
John Warner	Studebaker Corp.
R. E. Wilson	Standard Oil Co. of Indiana
J. F. Winchester	Standard Oil Co. of New Jersey
A. M. Wolf	Newark, N. J.
H. T. Woolson	Chrysler Motors

FRONT WHEEL ALIGNMENT SUBCOMMITTEE

J. M. Nickelsen, *Chairman*	University of Michigan
W. B. Barnes	Auburn Automobile Co.
F. F. Chandler	Ross Gear & Tool Co.
C. P. Grimes	Grimes Brake Engineering Service
Newton Hadley	Chrysler Motors
O. T. Kreusser	General Motors Corp.
B. J. Lemon	United States Rubber Co.
E. S. Marks	H. H. Franklin Mfg. Co.

FUELS SUBCOMMITTEE

(Cooperating with the National Automobile Chamber of Commerce, the American Petroleum Institute and the American Society for Testing Materials)

Neil MacCoull, *Chairman*	Texas Co.
B. B. Bachman	Autocar Co.
A. L. Beall	Vacuum Oil Co.
O. C. Berry	Borg-Warner Corp.
T. A. Boyd	General Motors Corp.
G. G. Brown	University of Michigan
H. R. Cobleigh	National Automobile Chamber of Commerce
H. M. Crane	General Motors Corp.
H. C. Dickinson	Bureau of Standards
C. S. Fliedner	Bureau of Aeronautics, Navy Department
S. D. Heron	Air Corps
H. L. Horning	Waukesha Motor Co.
W. S. James	Studebaker Corp.
E. T. Jones	Wright Aeronautical Corp.
C. S. Kegerreis	Tillotson Mfg. Co.
C. F. Kettering	General Motors Corp.
J. B. Macauley	Chrysler Motors
G. J. Mead	Pratt & Whitney Aircraft Co.
F. C. Mock	Stromberg Motor Devices Co.
W. C. Naylor	W. B. Stout Engineering & Finance Co.
Arthur Nutt	Curtiss Aeroplane & Motor Co., Inc.
Daniel Roesch	Armour Institute of Technology
Commander J. M. Shoemaker	Bureau of Aeronautics, Navy Department
Wesley L. Smith	National Air Transport, Inc.
S. W. Sparrow	Studebaker Corp.
P. S. Tice	Stewart-Warner Speedometer Corp.
R. E. Wilson	Standard Oil Co. of Indiana
J. F. Winchester	Standard Oil Co. of New Jersey
J. R. Wright	Standard Oil Development Co.

HEADLIGHT SUBCOMMITTEE

H. M. Crane, *Chairman*	General Motors Corp.
C. C. Bohner	Tung-Sol Lamp Works
H. S. Broadbent	Westinghouse Lamp Co.
R. E. Carlson	Edison Lamp Works of the General Electric Co.
H. C. Dickinson	Bureau of Standards
R. N. Falge	General Motors Corp.
W. T. Fishleigh	Ford Motor Co.
J. H. Hunt	General Motors Corp.
E. E. Huntington	Willys-Overland Co.
W. M. Johnson	National Lamp Works of the General Electric Co.
P. J. Kent	Chrysler Motors
E. S. Marks	H. H. Franklin Mfg. Co.
C. A. Michel	Guide Lamp Corp.
John Warner	Studebaker Corp.

HIGHWAYS SUBCOMMITTEE

(Cooperating with the Rubber Association of America and the U. S. Bureau of Public Roads)

B. B. Bachman, *Chairman*	Autocar Co.
R. W. Brown	Firestone Tire & Rubber Co.
H. C. Dickinson	Bureau of Standards
W. E. Lay	University of Michigan

of 28 existing standards, and the cancelling of 15 of the Society's specifications, have been submitted to the Standards Committee and the Society. Also, one report of a Sectional Committee has been approved by the Society as a sponsor. At the close of the year, 80 subjects were under active consideration by the Standards Committee.

Following the Standards Committee meeting in June, 1928, letter-ballots for approval of standards reports were mailed to 3037 members, in response to which 457 ballots were returned, 5 of which were unsigned. The only subject reported during the year that was withheld from publication following the letter-ballots was that on Aeronautical Instrument Mountings.

Probably the outstanding development in the Society's standardization activities was in aeronautics. The Aeronautical Division was very active throughout the year and held three largely attended aeronautical standardization sessions, in Detroit in April, in Los Angeles in September, and in Chicago in December.

S.A.E. Handbook

The 1928 issue of the S.A.E. Handbook was mailed to the members early in April. The complete Handbook was not reprinted following the adoption of standards at the Summer Meeting of the Society, in accordance with previous direction by the Council to print the complete Handbook but once a year. The reports adopted and the 36 reports approved at the Summer Meeting were printed in the Supplement to the Handbook issued to the members in September. These specifications, if not revised or cancelled, will be incorporated in the 1929 issue of the Handbook following this Annual Meeting of the Society. The manufacturers' listing is growing steadily, about 875 companies being listed in the 1928 Handbook, an increase of approximately 150 over the previous year. It is anticipated that more than 100 additional companies will be listed in the 1929 issue as sources of articles and materials fabricated in accordance with S.A.E. specifications.

Standards Surveys

Surveys of the extent to which the S.A.E. Standards are used and to determine whether they require reconsideration as to revision or cancellation have been continued during the year. These surveys are very useful to the Divisions of the Standards Committee in their current work.

Sectional Committees

The Society has continued to sponsor the Sectional Committees for which it was sponsor during the previous year. It has also named representatives on the following Sectional Committees during the year: Shafting, Motor-Frame Dimensions, Speeds of Driven Machines.

American Standards Association

The American Standards Association succeeded the American Engineering Standards Committee on Nov. 1 by action of the member-bodies, of which the Society is one. The principal changes in the organization were in name and in control function. The business administration of the A.S.A. is by a Board of Directors, the members of which it is planned shall be men, of the executive type, of broad experience. Matters relating to standardization are governed by the Standards Council. The Society is to be represented on the Board of Directors, as well as on the Standards Council. The major change in the prescribed procedure was to authorize the organizing of autonomous Sectional Committees, whereas previously Sectional Committees were always sponsored. The work in general under the procedure of the A.S.A. has expanded rapidly during the year. The Society is carrying its share of these activities.

Mechanical Standards Advisory Council

With the growth during the last few years of standardization on a National basis relating to all major industries, many problems arose that were frequently difficult to solve. The standardization activities under the American Standards Association can be classed generally as relating to the mechanical and the electrical industries and to safety codes. It was felt that an advisory body of some kind, that would be representative of the interests commonly referred to as mechanical, would serve a very useful purpose to the industry as an advisory body in matters relating to standardization and also to the American Standards Association in correlating mechanical standardization, serving as an impartial court of appeals in cases of dispute, and otherwise as occasion might require. This body will not formulate standards but will endeavor to bring inter-industrial standardization under the procedure of the A.S.A. The Society is directly connected with this undertaking, which was definitely established in October, by representation on the Executive Committee of the Mechanical Standards Advisory Council, in company with representatives of six other National societies and associations.

International Standardization

This work, as reported last year, has progressed slowly, although no new projects in which the Society is directly concerned have been undertaken during the year internationally.

General Interests

The Society has maintained its representation on such Committees other than its own as were reported last year. Many of these Committees have made appreciable progress during the last year. The results of their work will be of value in the general standardization activities.

H. M. Crane,
Chairman.

Treasurer's Report

This copy of the Comparative Balance Sheet and Income and Expense Comparison is distributed to the members so that they may see the exact condition of the Society's finances.

The income for the year is $12,939.58 less than for 1927, and $14,245.80 less than the budget, due principally to a falling off of revenue from advertising. Such falling off we anticipate will be prevented in 1929 by the increase of 20 per cent in the advertising rates, which has not been accompanied by any marked decrease in the number of contracts for the ensuing year. The Society's expenses have increased $13,933.28 over 1927, which is natural with the growth of the Society and the keeping up of the high standard of its activities. In spite of a decrease in revenue and an increase in expenditure, we had $4,599.64 unexpended income for the last fiscal year, and an increase of $13,418.37 in securities deposited with the Chemical National Bank of New York, all of which gives us the assurance that we hold an enviable position financially.

The Finance Committee and your Council have approved a Budget for 1929 of $395,000.00, an increase of $14,000.00 over 1928, which we believe can be maintained by increased efforts.

I cannot close without mentioning your very loyal and efficient office staff under the direction of our dear and untiring Coker Clarkson, for they all help to bring about these results.

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COMPARATIVE BALANCE SHEET AS OF SEPT. 30, 1928, AND SEPT. 30, 1927

(In agreement with Haskins & Sells audit of the same date)

Assets	1928	1927	Increase	Decrease
Cash	$13,765.55	$10,799.75	$2,965.80	....
Accounts Receivable	16,652.17	22,969.28	....	$6,317.11
Securities	192,330.75	178.912.38	13,418.37	....
Accrued Interest on Securities	3,178.33	2,880.00	298.33	....
Inventories	1,106.30	1,246.20	....	139.90
Furniture and Fixtures	2,248.58	2,872.39	....	623.81
Items Paid in Advance, Charges Deferred	7,427.74	8,900.30	....	1,472.56
TOTAL ASSETS	$236,709.42	$228,580.30	$8,129.12	....
Liabilities and Reserves				
Accounts Payable	$4,010.35	$11,593.07	....	$7,582.72
Dues and Miscellaneous Items Received in Advance	17,719.78	8,396.76	$9,323.02	....
Reserves Set Aside for Anticipated Expenses	3,921.13	2,168.95	1,752.18	....
General Reserve	206,458.52	174,949.02	31,509.50	....
Net Unexpended Income	4,599.64	31,472.50	....	26,872.86
TOTAL LIABILITIES AND RESERVES	$236,709.42	$228,580.30	$8,129.12	....

INCOME AND EXPENSE COMPARISON—12 MONTHS ENDED SEPT. 30

(In agreement with Haskins & Sells audit of the same date)

Income	1928	1927	Increase	Decrease
Dues and Subscriptions	$88,542.50	$84,303.00	$4,239.50	....
Affiliated Appropriations	7,500.00	7,500.00	....	....
Interest and Discount	9,843.17	9,120.54	722.63	....
Initiation Fees	17,640.00	16,535.00	1,105.00	....
Advertising Sales, S.A.E. JOURNAL	214,466.00	220,618.00	....	$6,152.00
Advertising Sales, S.A.E. HANDBOOK	11,000.00	16,650.00	....	5,650.00
Miscellaneous Sales	16,617.28	24,967.24	....	8,349.96
Profit from Sales of Securities	1,145.25	....	1,145.25	....
TOTAL INCOME	$366,754.20	$379,693.78	....	$12,939.58
Expense				
Publications	$93,583,13	$89,503.20	$4,079.93	....
Sections	13,809.65	8,735.38	5,074.27	....
Research	16,787.40	15,331.20	1,456.20	....
Employment Service	3,265.01	3,382.12	....	$117.11
Standards	24,561.74	22,772.02	1,789.72	....
Meetings—Net Cost[1]	27,683.15	24,388.82	3,294.33	....
Cost of Membership Increase	12,095.78	11,407.71	688.07	....
Cost of Advertising Sales, S.A.E. JOURNAL	64,491.90	63,501.04	990.86	....
Cost of Advertising Sales, S.A.E. HANDBOOK	2,222.84	3,000.39	....	777.55
Cost of Miscellaneous Sales	7,094.70	15,560.52	....	8,465.82
S.A.E. Operation and Maintenance Committee	287.71	322.93	....	35.22
S.A.E. Production Committee	193.77	85.99	107.78	....
Army Ordnance Advisory Committee	30.61	....	30.61	....
General Expense	96,047.17	90,220.96	5,817.21	....
TOTAL EXPENSE	$362,154.56	$348,221.28	$13,933.28	....
Net Unexpended Income	$4,599.64	$31,472.50	....	$26,872.86

[1] Ticket sales and other receipts deducted.

C. B. WHITTELSEY,
Treasurer.

The Moving and Raising of Monoliths

HOW the moving and raising of large monoliths was effected in ancient times by huge numbers of laborers under the then conditions of mechanical knowledge has been a common subject of speculation and discussion, for the amount of labor required was dependent on the low-efficiency primitive appliances supposed to have been available and used.

The work of the Italian etcher Piranesi, on the Campus Martius, published in Rome in 1762, contains two plates relating to the raising of the Antonine Column, 90 tons, to a height of 40 ft., in 1705. These etchings were produced with access to records and to the memory of living men.

In more recent times the methods have been greatly improved and the handling, transporting and raising of Cleopatra's Needle, 200 tons, to a height of 50 ft., in 1878 is well within living memory.

The labor required for raising the Antonine Column amounted to 416 capstan-hands, working 16 on and 16 off at each of the 13 capstans, apart from foreman, gangers and others.

The labor required for raising Cleopatra's Needle by means of hydraulic jacks was reduced to that of one man, though, according to contemporary trade advertisements, two men actually worked at the raising. Even so, the quantity of labor had been reduced in 170 years by over 99.5 per cent, and in making a fair comparison it should be remembered that Cleopatra's Needle was more than double the weight of the Antonine Column.—L. A. Segros.

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1929 Committees of the Society

THERE is listed below the personnel for 1929 of the bulk of the Society Committees, including the technical committees such as the Research and the Standards Committees and their Subcommittees and Divisions; committees auxiliary and subsidiary to these Committees; professional activities committees such as the Production and the Transportation Committees; Sectional Committees, organized under the procedure of the American Standards Association, sponsored by or participated in by the Society; and special committees organized and representatives appointed to cooperate with other civilian and with Governmental organizations.

The personnel of the 1929 Administrative Committees and of the Motor-Vehicle and the Aeronautical Committees, is given in the account in this issue of January Council meetings on p. 246.

TECHNICAL COMMITTEES

Research Committee

H. L. Horning, *Chairman*	Waukesha Motor Co.
B. B. Bachman	Autocar Co.
O. C. Berry	Borg-Warner Corp.
R. W. Brown	Firestone Tire & Rubber Co.
F. F. Chandler	Ross Gear & Tool Co.
H. M. Crane	General Motors Corp.
H. C. Dickinson	Bureau of Standards
A. W. Herrington	Coleman Motors Corp.
E. R. Hewitt	International Motor Co.
H. A. Huebotter	Butler Mfg. Co.
J. H. Hunt	General Motors Corp.
H. M. Jacklin	Purdue University
W. S. James	Studebaker Corp.
C. F. Kettering	General Motors Corp.
W. E. Lay	University of Michigan
B. J. Lemon	United States Rubber Co.
Benjamin Liebowitz	New York City
E. H. Lockwood	Yale University
Neil MacCoull	Texas Co.
F. C. Mock	Stromberg Motor Devices Co.
A. L. Nelson	Bohn Aluminum & Brass Corp.
Arthur Nutt	Curtiss Aeroplane & Motor Co., Inc.
V. P. Rumely	Hudson Motor Car Co.
S. W. Sparrow	Studebaker Corp.
W. R. Strickland	Cadillac Motor Car Co.
W. G. Wall	Indianapolis
E. P. Warner	Assistant Secretary of the Navy for Aeronautics
John Warner	Studebaker Corp.
R. E. Wilson	Standard Oil Co. of Indiana
J. F. Winchester	Standard Oil Co. of New Jersey
A. M. Wolf	Newark, N. J.
H. T. Woolson	Chrysler Motors

FRONT WHEEL ALIGNMENT SUBCOMMITTEE

J. M. Nickelsen, *Chairman*	University of Michigan
W. B. Barnes	Auburn Automobile Co.
F. F. Chandler	Ross Gear & Tool Co.
C. P. Grimes	Grimes Brake Engineering Service
Newton Hadley	Chrysler Motors
O. T. Kreusser	General Motors Corp.
B. J. Lemon	United States Rubber Co.
E. S. Marks	H. H. Franklin Mfg. Co.

FUELS SUBCOMMITTEE

(Cooperating with the National Automobile Chamber of Commerce, the American Petroleum Institute and the American Society for Testing Materials)

Neil MacCoull, *Chairman*	Texas Co.
B. B. Bachman	Autocar Co.
A. L. Beall	Vacuum Oil Co.
O. C. Berry	Borg-Warner Corp.
T. A. Boyd	General Motors Corp.
G. G. Brown	University of Michigan
H. R. Cobleigh	National Automobile Chamber of Commerce
H. M. Crane	General Motors Corp.
H. C. Dickinson	Bureau of Standards
C. S. Fliedner	Bureau of Aeronautics, Navy Department
S. D. Heron	Air Corps
H. L. Horning	Waukesha Motor Co.
W. S. James	Studebaker Corp.
E. T. Jones	Wright Aeronautical Corp.
C. S. Kegerreis	Tillotson Mfg. Co.
C. F. Kettering	General Motors Corp.
J. B. Macauley	Chrysler Motors
G. J. Mead	Pratt & Whitney Aircraft Co.
F. C. Mock	Stromberg Motor Devices Co.
W. C. Naylor	W. B. Stout Engineering & Finance Co.
Arthur Nutt	Curtiss Aeroplane & Motor Co., Inc.
Daniel Roesch	Armour Institute of Technology
Commander J. M. Shoemaker	Bureau of Aeronautics, Navy Department
Wesley L. Smith	National Air Transport, Inc.
S. W. Sparrow	Studebaker Corp.
P. S. Tice	Stewart-Warner Speedometer Corp.
R. E. Wilson	Standard Oil Co. of Indiana
J. F. Winchester	Standard Oil Co. of New Jersey
J. R. Wright	Standard Oil Development Co.

HEADLIGHT SUBCOMMITTEE

H. M. Crane, *Chairman*	General Motors Corp.
C. C. Bohner	Tung-Sol Lamp Works
H. S. Broadbent	Westinghouse Lamp Co.
R. E. Carlson	Edison Lamp Works of the General Electric Co.
H. C. Dickinson	Bureau of Standards
R. N. Falge	General Motors Corp.
W. T. Fishleigh	Ford Motor Co.
J. H. Hunt	General Motors Corp.
E. E. Huntington	Willys-Overland Co.
W. M. Johnson	National Lamp Works of the General Electric Co.
P. J. Kent	Chrysler Motors
E. S. Marks	H. H. Franklin Mfg. Co.
C. A. Michel	Guide Lamp Corp.
John Warner	Studebaker Corp.

HIGHWAYS SUBCOMMITTEE

(Cooperating with the Rubber Association of America and the U. S. Bureau of Public Roads)

B. B. Bachman, *Chairman*	Autocar Co.
R. W. Brown	Firestone Tire & Rubber Co.
H. C. Dickinson	Bureau of Standards
W. E. Lay	University of Michigan

B. J. Lemon	United States Rubber Co.
Benjamin Liebowitz	New York City
A. L. Schoff	Overman Cushion Tire Co.
J. A. Sloan	International Motor Co.
J. F. Winchester	Standard Oil Co. of New Jersey

RIDING QUALITIES SUBCOMMITTEE

R. W. Brown, *Chairman*	Firestone Tire & Rubber Co.
F. F. Chandler	Ross Gear & Tool Co.
H. C. Dickinson	Bureau of Standards
Tore Franzen	Chrysler Motors
H. M. Jacklin	Purdue University
Benjamin Liebowitz	New York City
T. J. Lítle, Jr.	Marmon Motor Car Co.
Orrel A. Parker	Parker Wheel Co.
W. R. Strickland	Cadillac Motor Car Co.
W. G. Wall	Indianapolis
E. P. Warner	Assistant Secretary of the Navy for Aeronautics
John Warner	Studebaker Corp.

STANDARDS COMMITTEE

A. J. Scaife, *Chairman*	White Motor Co.
A. Boor, *Vice-Chairman*	Willys-Overland Co.
G. L. McCain, *Vice-Chairman*	Chrysler Motors

AGRICULTURAL POWER EQUIPMENT DIVISION

O. B. Zimmerman, *Chairman*	International Harvester Co.
R. O. Hendrickson, *Vice-Chairman*	J. I. Case Threshing Machine Co., Inc.
A. H. Gilbert	Rock Island Plow Co.
P. E. Holt	Caterpillar Tractor Co.
John Mainland	Advance-Rumely Co.
A. C. Rasmussen	Insley Mfg. Co.
O. W. Sjogren	Department of Agricultural Engineering, University of Nebraska
G. A. Young	School of Mechanical Engineering, Purdue University

AIRCRAFT DIVISION

E. P. Warner, *Chairman*	Assistant Secretary of the Navy for Aeronautics
Mac Short, *Vice-Chairman*	Stearman Aircraft Co.
Don M. Alexander	Alexander Aircraft Co.
John R. Cautley	Bendix Brake Co.
J. F. Hardecker	Naval Aircraft Factory
Lieut. C. B. Harper	Bureau of Aeronautics, Navy Department
H. A. Hicks	Stout Metal Airplane Co. Division, Ford Motor Co.
Major C. W. Howard	Materiel Division, Air Corps
I. M. Laddon	Consolidated Aircraft Corp.
K. M. Lane	Wright Aeronautical Corp.
B. J. Lemon	United States Rubber Co.
Ralph G. Lockwood	Fairchild Airplane Mfg. Co.
C. J. McCarthy	Chance Vought Corp.
C. N. Montieth	Boeing Airplane Co.
W. C. Naylor	W. B. Stout Engineering & Finance Co.
C. T. Porter	Keystone Aircraft Corp.
L. D. Seymour	National Air Transport, Inc.
J. G. Swain	Firestone Steel Products Co.
Edward Wallace	Great Lakes Aircraft Corp.
T. P. Wright	Curtiss Aeroplane & Motor Co., Inc.

AIRCRAFT ENGINE DIVISION

L. M. Woolson, *Chairman*	Packard Motor Car Co.
Arthur Nutt, *Vice-Chairman*	Curtiss Aeroplane & Motor Co., Inc.
L. M. Griffith	Emsco Aero Engine Co.
Edward D. Herrick	Lycoming Mfg. Co.
Robert Insley	Continental Motors Corp.
E. T. Jones	Wright Aeronautical Corp.
Bruce G. Leighton	Wright Aeronautical Corp.
Ludwig Majneri	Warner Aircraft Corp.
G. J. Mead	Pratt & Whitney Aircraft Co.
Commander J. M. Shoemaker	Bureau of Aeronautics, Navy Department
Capt. T. E. Tillinghast	Engineering Division, Air Corps
W. L. Velie, Jr.	Velie Motors Corp.

AXLE AND WHEELS DIVISION

O. A. Parker, *Chairman*	Parker Wheel Co.
George Walther, *Vice-Chairman*	Dayton Steel Foundry Co.
B. B. Bachman	Autocar Co.
R. S. Begg	Budd Wheel Co.
L. R. Buckendale	Timken-Detroit Axle Co.
G. W. Carlson	Eaton Axle & Spring Co.
C. C. Carlton	Motor Wheel Corp.
G. W. Harper	Columbia Axle Co.
E. R. Jacobi	Kelsey-Hayes Wheel Corp.
W. F. Rockwell	Wisconsin Parts Co.
F. L. Sage	Graham Bros.

BALL AND ROLLER BEARINGS DIVISION

H. E. Brunner, *Chairman*	S.K.F. Industries, Inc.
G. R. Bott, *Vice-Chairman*	Norma-Hoffmann Bearings Corp.
E. R. Carter, Jr.	Fafnir Bearing Co.
D. F. Chambers	The Bearings Co. of America
L. A. Cummings	Marlin-Rockwell Corp.
T. C. Delaval-Crow	New Departure Mfg. Co.
H. R. Gibbons	Hyatt Roller Bearings Division, General Motors Corp.
B. H. Gilpin	H. H. Franklin Mfg. Co.
G. E. Parker	Cadillac Motor Car Co.
H. N. Parsons	Strom Bearings Co.
Ernest Wooler	Timken Roller Bearing Co.

ELECTRICAL EQUIPMENT DIVISION

A. R. Lewellen, *Chairman*	Chevrolet Motor Co.
D. M. Pierson, *Vice-Chairman*	Chrysler Motors
Azel Ames	Kerite Insulated Wire & Cable Co., Inc.
A. K. Brumbaugh	White Motor Co.
D. S. Cole	Leece-Neville Co.
W. S. Haggott	Packard Electric Co.
L. M. Kanters	Waukesha Motor Co.
T. L. Lee	North East Electric Co.
L. E. Lighton	Electric Storage Battery Co.
L. O. Parker	Delco-Remy Corp.
E. K. Schadt	Cadillac Motor Car Co.
T. E. Wagar	Studebaker Corp.

ENGINE DIVISION

E. S. Marks, *Chairman*	H. H. Franklin Mfg. Co.
A. W. Scarratt, *Vice-Chairman*	International Harvester Co.
Paul Bastien	Stutz Motor Car Co. of America, Inc.
H. C. Blake	Springfield, Ohio
R. J. Broege	Buda Co.
C. L. Cummins	Cummins Engine Co.
J. B. Fisher	Waukesha Motor Co.
J. D. Harris	McCord Radiator & Mfg. Co.
E. D. Herrick	Lycoming Mfg. Co.
Thomas Jackson	Continental Motors Corp.
C. B. Jahnke	Fairbanks, Morse & Co.
E. T. Larkin	Sterling Engine Co.
A. F. Milbrath	Wisconsin Motor Mfg. Co.
L. P. Saunders	Harrison Radiator Corp.
H. G. Smith	Hercules Motors Corp.
V. C. Young	International Motor Co.

IRON AND STEEL DIVISION

J. M. Watson, *Chairman*	Hupp Motor Car Corp.
A. H. d'Arcambal *Vice-Chairman*	Pratt & Whitney Co.
J. R. Adams	Midvale Co.
R. J. Allen	Rolls-Royce of America, Inc.
A. L. Boegehold	General Motors Corp. Research Laboratories
Henry Chandler	Vanadium Corp. of America
J. D. Cutter	Fafnir Bearing Co.
B. H. DeLong	Carpenter Steel Co.
F. P. Gilligan	Henry Souther Engrg. Corp.
H. W. Graham	Jones & Laughlin Steel Corp.
H. L. Greene	Willys-Overland Co.
E. J. Janitzky	Illinois Steel Co.
J. A. Mathews	Crucible Steel Co. of America
W. C. Peterson	Donner Steel Co.
E. A. Portz	Central Alloy Steel Corp.
S. P. Rockwell	Stanley P. Rockwell Co.
R. B. Schenck	Buick Motor Co.
W. R. Shimer	Bethlehem Steel Co.
Ralph R. Teetor	Perfect Circle Co.
H. P. Tiemann	Carnegie Steel Co.
E. W. Upham	Chrysler Motors
T. H. Wickenden	International Nickel Co.
O. B. Zimmerman	International Harvester Co.

LIGHTING DIVISION

C. A. Michel, *Chairman*	Guide Lamp Corp.
R. N. Falge, *Vice-Chairman*	General Motors Corp. Research Laboratories
Clyde C. Bohner	Tung-Sol Lamp Works
H. S. Broadbent	Westinghouse Lamp Co.
R. E. Carlson	Edison Lamp Works of the General Electric Co.
A. W. Devine	Registry of Motor Vehicles, Commonwealth of Massachusetts
H. C. Doane	Buick Motor Co.
G. P. Doll	Corcoran Lamp Co.
R. W. Johnson	John W. Brown Mfg. Co.
W. M. Johnson	National Lamp Works of the General Electric Co.
A. R. Lewellen	Chevrolet Motor Co.
D. M. Pierson	Chrysler Motors
W. F. Thoms	Indiana Lamp Corp.
T. E. Wagar	Studebaker Corp.

LUBRICANTS DIVISION

E. W. Upham, *Chairman*	Chrysler Motors
H. C. Mougey, *Vice-Chairman*	General Motors Corp. Research Laboratories
Sydney Bevin	Tide Water Oil Co.
A. B. Boehm	Standard Oil Co. of New Jersey
O. E. Eckert	Mid-Continent Petroleum Corp.
J. B. Fisher	Waukesha Motor Co.
J. C. Geniesse	Atlantic Refining Co.
W. H. Graves	Packard Motor Car Co.
C. M. Larson	Sinclair Refining Co.
K. G. Mackenzie	Texas Co.
W. H. Oldacre	D. A. Stuart & Co.
W. F. Parish	New York City
G. A. Round	Vacuum Oil Co.
H. J. Saladin	Standard Oil Co. of Indiana
W. A. P. Schorman	British American Oil Co., Ltd.
F. D. Shields	Transcontinental Oil Co.
B. E. Sibley	Continental Oil Co.
C. W. Simpson	White Motor Co.
H. G. Smith	Gulf Refining Co.
J. B. Terry	Standard Oil Co. of California
R. E. Wilson	Standard Oil Co. of Indiana

MOTORBOAT AND MARINE ENGINE DIVISION

Leonard Ochtman, Jr., *Chairman*	Elco Works
C. A. Carlson	Remington Oil Engine, Inc.
N. E. Donnelly	Dawn Boat Corp.
H. E. Fromm	Chrysler Sales Corp.
S. Clyde Kyle	American Car & Foundry Co.
H. R. Sutphen	Submarine Boat Corp.
Joseph Van Blerck	Van Blerck Motors, Inc.

MOTORCOACH DIVISION

A. J. Scaife, *Chairman*	White Motor Co.
S. W. Mills, *Vice-Chairman*	Pierce-Arrow Motor Car Co.
W. F. Klein	General Motors Truck Co.
A. A. Lyman	Public Service Coordinated Transport
L. H. Palmer	Fifth Avenue Coach Co.
A. W. Scarratt	International Harvester Co.
G. R. Scragg	Mack-International Motor-Truck Corp.
P. V. C. See	Northern Ohio Power & Light Co.
F. A. Whitten	McCord Radiator & Mfg. Co.

MOTOR-TRUCK DIVISION

F. A. Whitten, *Chairman*	McCord Radiator & Mfg. Co.
B. B. Bachman, *Vice-Chairman*	Autocar Co.
W. J. Baumgartner	Relay Motors Corp.
Carl J. Bock	General Motors Truck Co.
A. W. Herrington	Coleman Motors Corp.
M. C. Horine	International Motor Co.
S. W. Mills	Pierce-Arrow Motor Car Co.
A. J. Scaife	White Motor Co.
A. W. Scarratt	International Harvester Co.
E. M. Schultheis	Timken Roller Bearing Co.
Ernest M. Sternberg	Sterling Motor Truck Co.

NON-FERROUS METALS DIVISION

Zay Jeffries, *Chairman*	Aluminum Co. of America
C. W. Simpson, *Vice-Chairman*	White Motor Co.
W. H. Bassett	American Brass Co.
C. H. Calkins	Baush Machine Tool Co.
D. L. Colwell	Stewart Die Casting Corp.
H. R. Corse	Lumen Bearing Co.
W. A. Cowan	National Lead Co.
P. V. Faragher	United States Aluminum Co.
W. H. Graves	Packard Motor Car Co.
H. L. Greene	Willys-Overland Co.
J. B. Johnson	Engineering Division, Air Corps
R. R. Moore	Wright Aeronautical Corp.
H. C. Mougey	General Motors Corp. Research Laboratories
A. L. Nelson	Bohn Aluminum & Brass Corp.
W. M. Peirce	New Jersey Zinc Co.
W. B. Price	Scovill Mfg. Co.
T. H. Wickenden	International Nickel Co.
H. M. Williams	Frigidaire Corp.

PARTS AND FITTINGS DIVISION

A. Boor, *Chairman*	Willys-Overland Co.
Ivan Ornberg, *Vice-Chairman*	Hupp Motor Car Corp.
A. K. Brumbaugh	White Motor Co.
R. V. Hutchinson	Olds Motor Works
H. S. Jandus	C. G. Spring & Bumper Co.
W. C. Keys	United States Rubber Co.
G. L. McCain	Chrysler Motors
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Larger Airplanes an Economic Need

THE trend of the human mind is to deny as impractical that which has not yet been accomplished, so the pioneers of an industry have literally to fight for every inch they move forward. It usually requires generations to put into general use what the inventor has made possible. The man without vision, the man who stands still in his tracks, prefers to call himself conservative and often alludes to the pioneer as impractical. But who is the more impractical, the pioneer who points out the newer and better methods, or the so-called conservative who denies that the newer methods are possible?

It is no more difficult to build a 100-passenger airplane today than it was to build an 18-passenger airplane in 1919; but it is just as difficult to make others understand that a 100-passenger plane can be built today as it was to make them understand that I could build an 18-passenger plane 10 years ago.

The 100-passenger airplane is more economical than the 18-passenger plane, just as the 18-passenger plane is more economical than the two-passenger plane. Furthermore, the 200-passenger airplane will be more economical than the 100-passenger plane.

As the size of the double passenger-tier plane is increased, the horsepower and the total load per passenger is decreased, so the larger airplanes decrease the cost of operation per passenger; therefore, the fares can be reduced. The operation of 100-passenger double-tier planes makes possible the cutting of passenger fares on airliners below those charged by railroads. Larger passenger-airplanes therefore are necessary to solve the problem of the cost of operation per passenger.

There is no more reason to expect that a 10-passenger plane can be operated at a low cost per passenger than there would be to expect that a 10-passenger train could be operated at a low cost per passenger.

In due time old Father Economics will force even the most conservative to recognize the necessity for the large double-tier passenger airliner, with its cheap passenger-fares. And when that time comes, the masses will take to air travel as they now take to railroad travel.

The people who deny that these things can be accomplished are the impractical ones. The airplane industry will go just as far ahead as its pioneers are capable of seeing. The financiers, however, must furnish the motive power to get there.—From address by Alfred W. Lawson, at the International Civil Aeronautics Conference.

Drivers and Safety Measures

Selection, Training and Payment of Men and Safe Operating Methods Studied

METHODS used by various companies in selecting and training drivers, their payment, and the practices relating to safety of operation were the subjects considered by Subcommittee No. 5 of the Operation and Maintenance Committee, and these were reported upon by Ethelbert Favary, Chairman of the Subcommittee, at the Transportation Meeting held in Newark, N. J., Oct. 18, 1928. The report is as follows:

Report of Sub-Committee No. 5

The driver of a motor-vehicle has under his control a valuable piece of equipment. He represents the largest single factor which determines whether the results obtained from the vehicle are satisfactory and its operating costs excessive or within reason. He is completely out of supervision during the time the greatest part of the operating expenses are incurred. His carelessness may cause damages amounting to many thousands of dollars, while his ability as a driver may save the company thousands of dollars in the course of a few years; hence, the selecting and training of a driver should be conducted with the utmost care.

SELECTING DRIVERS

It is recommended that one man in the organization have full responsibility for the selection of drivers. He should be a man of broad experience in judging human nature and all phases of motor-vehicle operation. Different types and models of motor-vehicle require different driver-qualifications; for heavy dump-trucks or heavy-duty trucks, light delivery-trucks, city motorcoaches and long-distance stages, taxicabs, oil-tank trucks and sales trucks, where customer contact is important. Each type has its special requirements and demands a driver of more or less specific qualifications to obtain the greatest efficiency.

Different methods are employed by different corporations in the selecting and training of drivers, and to assure safety of operation and freedom from accidents. Broadly, the following fundamentals are recommended:

(1) Experience; to judge qualifications

(2) Character; to judge reliability and sense of justice regarding rights of others

(3) Physical condition; applicants not in good health rejected

(4) Age; corporations have age limits for drivers

(5) If married; married men are preferred by some companies

(6) Intelligence; ability to form good judgment quickly, required by corporations where drivers fill out forms and make reports

(7) Traffic laws; applicant must be familiar with local and State traffic laws

(8) Personal appearance; especially required by cab and coach companies, or where drivers contact with clients

(9) Actual driving test; ability to handle equipment

(10) Coordination between mind and body; to test response of muscular system to emergencies

(11) Fitness for the work; driving must appeal to the men

EXPERIENCE

The applicant is informed of the wage scale and working conditions and is admonished to tell the truth, as he would be dismissed if it were found that he misstated facts in his application. A number of companies make it a strict rule to investigate every reference given by an applicant as to his experience with former employers. Other corporations investigate the applicant's record for the last 5 years.

The first move in the selection of an applicant for a position as driver is to determine his experience, with a view to judging his qualifications and ability as a driver. There are, however, some exceptions. One stage company says that experience in driving is unnecessary, because it wishes to teach the new driver the correct method from the start, provided all his other qualifications are satisfactory. This company also specifically states that taxicab experience is not acceptable, the supposition being that a man accustomed to driving a taxicab is handicapped for other driving, as taxicab drivers habitually wind their way in and out of traffic and take chances which other corporations do not countenance. This practice is most difficult to check, as passengers are often in a hurry and demand speed.

Some companies prefer drivers who have a mechanical ear, so to say, that enables them to detect quickly if the vehicle is not working normally; but they prefer men who are not mechanically inclined, for such men like to tinker with the mechanism, and this is a disadvantage except in cases in which the company owns only a few trucks or where drivers must make their own adjustments and minor repairs.

CHARACTER

Companies carefully investigate the previous record of each applicant, not only to ascertain his driving qualifications, but also to judge his reliability and his sense of justice regarding the rights of others. They not only interview his former superiors but some companies like to inquire of his former associates whether the applicant did not try to take unfair advantage of others. Some companies require the applicant to fill out a release authorizing his former employers to furnish all information of his previous records and all information they may have concerning him, he releasing the former employer from all liability for any damage whatsoever on account of furnishing this information. By having such a release from the applicant, the former employer feels freer to furnish any and all information that he has about the applicant. Companies selecting applicants wish to find out his compliance with company regulations, as well as with the city and State laws, to determine whether or not he is a law-abiding citizen.

PHYSICAL CONDITION

Most of the large companies require applicants to submit to a thorough physical examination by the company doctor. With the larger motorcoach-operating companies this examination is, as a rule, very exacting and similar to the usual railroad examination. A man must be in good physical condition and, if the work is heavy, as in driving heavy commercial vehicles, some companies specify the minimum weight of their drivers. A man rejected by the company doctor should not be employed. He must have good vision, good hearing and his arms and limbs should have no defects which will prevent him from using them effectively in driving.

Age

Various corporations have age limits, depending on the class of work for which they need drivers. This limit varies greatly. Some motorcoach companies and long-distance stage companies, which require extra skill and level-headedness, select men between the ages of 24 and 36 years; other companies may accept them between the ages of 18 and 45.

Married Men

Many companies prefer married men because they are steadier and not so much inclined to rove about or to keep late hours. They are also more interested in keeping at work on account of their family being dependent on them, and are ambitious to settle down and make good. It is also found that men who are happily married are of a more cheerful disposition than others and make more careful drivers.

Intelligence Test

A number of the large companies, especially city and interurban motorcoach companies, require the drivers to make out daily reports, and this involves a certain amount of clerical work. Truck companies require reports as to the condition of the vehicle after each day's run and, if the driver is away from his base for a large portion of the day, he must make a record of the purchases necessary for the operation of his vehicle. For this reason some companies submit the applicant to what may be termed an "intelligence test." This varies with different companies. Some companies submit a number of easy problems in simple addition, subtraction, multiplication and division to the applicant and he is given about one minute for answering each problem. To pass his examination, he must show 80 per cent efficiency. The companies which make this test claim that approximately one-third of all applicants are rejected for failure to pass. In other companies the applicant is asked a number of questions; for instance, one company asks the following questions:

(1) Have you a driver's license?

(2) Have you read the State motor-vehicle laws?

(3) What is the maximum speed allowed by law in the following districts; open country, business, residence and school?

(4) Who has the right of way when backing away from the curb?

(5) What are the proper signals to give when turning left, right and stopping?

(6) How far before turning should a signal be given?

(7) Is it legal to coast?

(8) How much weight can you carry legally on four wheels? How much weight on six-wheel vehicles? How much weight on any one axle? How much weight per inch of tire width?

(9) What is the permissible speed on solid tires and on pneumatic tires?

(10) When is a red flag needed and what size should it be?

When the applicant answers these or similar questions, his intelligence can be estimated to a fair degree. The speed with which he answers the questions may also form a basis as to his ability to form good judgment quickly. The intelligence test is especially important for motorcoach drivers who, in addition to the actual mechanical operation of the coach, come into contact with the public when collecting fares and issuing tickets.

A driver should be able to form good judgment quickly regarding what is safe or unsafe to do. He should be able to judge speed and distance, and various means are employed by different companies in their oral and written examinations to determine his ability in this respect.

Traffic Laws

The applicant must be familiar with local and State traffic laws. As many cities have their own traffic ordinances, the applicant must be familiar with the local ordinances; for instance, ordinances relating to passing streetcars, school crossings, special restrictions in congested business districts and the like. Some companies submit applicants to both oral and written examination regarding traffic laws, and the men must answer at least 80 per cent correctly to pass and be eligible for a position.

Personal Appearance

Where drivers come into contact with clients, as in cab companies, motorcoach companies and on delivery trucks that deliver high-class merchandise, the personal appearance of the applicant is taken into consideration. Personal appearance will attract patronage and, where drivers assist in the selling of goods, a neat appearance is very important, as it helps in making a good impression. Taxicab drivers, in soliciting fares, find neatness especially valuable.

Driving Test

This test determines the ability of the driver to handle the equipment and, while there are some exceptions among companies, most of them require the applicant to pass a strict driving test. Some companies pay careful attention to seeing if he can, in emergencies, drive his equipment without a hitch. Motorcoach companies regard it as dangerous to employ a man until he is thoroughly conversant with the type of equipment he has to drive. They sometimes find that drivers who have had years of experience with other types and who are of a rather slow mental type do not make successful drivers where the equipment is different; therefore, these companies give the driver a thorough test in the equipment he will have to handle.

Driving tests are conducted by an instructor or a supervisor. A man must go through the operation of starting the engine, shifting through the various gears, double clutching, bringing the vehicle to a stop and starting again, and going up or down hill. Motorcoach-company drivers are also required to back the vehicle around a corner and then to place it alongside the curb.

Coordination of Mind and Body

For responsiveness of the muscular system to emergencies, the driver should have proper coordination between his muscular and nervous system. This can be tested by noting the speed with which he carries out orders given him in the operating of a truck. The time consumed by some men is very considerable, and many accidents can be traced to the slowness of response of the muscular system. A man also should have sufficient emotional stability not to become confused in emergencies. Companies find that, within a few days, either during the selection or the training, they are able to form a good judgment of the applicant's coordination between mind and body.

Fitness for the Work

Sometimes a man has all the qualifications necessary for a driver and yet is not considered suitable because of his superior intelligence, which may fit him for a position of higher responsibility. If such a man were engaged he would become dissatisfied and inattentive and might be looking for a change of employment after a few months when he sees that his chances for advancement are necessarily slow. For this reason companies prefer to select men who are not too "good" to be safe for the job, and who are likely to be permanently satisfied.

TRAINING DRIVERS

Corporations, with few exceptions, do not train novices in the art of driving. After an applicant has completed the various examinations and tests, he must undergo intensive training. This may vary in length from one day to one month, depending on the company and the driver. The training is undertaken for the purpose of making the driver efficient in his work of handling the equipment confided to his care, to train him to become a careful driver and to have the utmost regard for the safety of passengers, pedestrians and property, and

to make him conscious of the responsibility placed on him.

It should be imparted to him early that a driver behind the steering-wheel of a motor-vehicle can be more dangerous than a man with a gun, and that the motor-vehicle may become an engine of destruction in the hands of an irresponsible driver. By imbuing him with this conception when he first enters the employment of any company, and at frequent intervals thereafter, he will be made to realize his responsibility. The training of drivers can be placed under the following headings:

Details of Training Methods

(1) Class instruction: to familiarize drivers with the type of equipment used, rules and regulations of the company, and routes on which to travel

(2) Care of equipment: training drivers in careful handling of equipment

(3) Actual driving, accompanied by a supervisor

(4) Filling out forms and making reports

(5) Securing witnesses in case of accident

(6) Safe and careful operation: this is stressed at the time the driver enters the company's service and periodically thereafter.

(7) Vigilance: constant vigilance continually impressed on drivers.

Some companies do not give class instruction (1), but individual instruction; whereas others begin with class instruction and finish with individual instruction. There is a difference in the different makes of equipment, and the driver should be trained as to the characteristics of the equipment he has to handle. He is trained in the procedure to pursue when starting a particular make of motor-vehicle, how to set the spark lever and the throttle for best results, and how to avoid choking and the ill results arising from excessive choking. With the motorcoach companies he is made familiar with the tickets, transfers and fare-collection system; taxicab companies acquaint him with the various charges for extra persons, charges for luggage carried near the driver's seat and the like. The driver is made familiar with the special rules and regulations of the company, and he is instructed about the tariffs charged by motorcoach and freight companies in cases in which he has to collect fares or charges.

Coach companies also instruct drivers where to make stops and concerning station calls and terminals; and trucking companies inform him as to the best routes to follow and convey cimilar information.

Care of Equipment

Drivers are trained in the care of handling the equipment so as to reduce the expense of upkeep. They are shown the most efficient ways of taking care of individual units in cases in which the driver looks after the lubrication of his vehicle. This usually is not required with the larger companies, but there are exceptions; for instance, where drivers are away from their base for several days.

Actual Driving Accompanied by Supervisor

The applicant is assigned to ride in one of the vehicles. At first he watches the foreman or instructor drive, then is allowed to drive and is closely watched by the instructor.

Coach companies at first permit him to collect fares and issue transfers to become familiar with these duties. A day or two later he is permitted to drive; but in the case of city service he is not immediately allowed to drive through the heart of the traffic but only at the ends of the line where the traffic is light. After he has been found competent, he is allowed to drive through traffic, but is still under the watchful eye of the instructor, who sits in the seat directly behind him. He is watched for a period of approximately eight days, which constitutes the "breaking-in period." This time varies with different companies.

One long-distance stage company gives some very interesting statistics. It shows that, of 450 applicants, 138 were started to be broken-in, and only 85 finished their training and were accepted. Of the 138 who started, 24 failed to qualify in the tryout period; 24 dropped out for various reasons; 4 could not finance themselves; and 4 had police records.

Usually, on long-distance stage work, in which different fares are charged between different points, the company requires a longer breaking-in period for drivers. They are trained to keep to the right side of the road and, before passing another car from the rear, first to pull out to the left to see if the road ahead is clear. They are instructed not to obstruct traffic on congested highways by trying to pass singly every car they overtake, but to trail along until the cars ahead are bunched in threes or fours and then to pass the bunch when they have a clear road. They are told that they can make as good time by driving easily and taking no chances on a congested highway as they can by trying to pass everything in sight, and with less fatigue and nerve strain. They are cautioned never to drive around a curve with the brakes set, but to reduce speed beforehand and then release the brakes when rounding the curve. The training includes the use of the brakes to the best advantage, with instruction never to coast with the engine disconnected, and similar details.

Making Reports

The scope of this subject varies considerably with different companies. It is more extended for stage-coach drivers than for drivers for other companies. It includes the filling out of the various forms used in the daily reports, as well as the reports about any faults in the mechanism of the vehicle, reporting accidents, and the like.

Securing Witnesses to Accidents

The men are carefully trained as to the correct procedure in case of accident and how to secure witnesses. The kind of instruction depends largely on the type of service in which they are engaged, and it is more comprehensive with some companies than with others.

Safe and Careful Operation

The most successful training to avoid accidents has been by stressing "safe-and-sane" driving at the time the driver enters the company's employment, and periodically thereafter. Additional information on this subject is given under the heading Operating Safety Measures.

Vigilance

Continuous impressing upon the driver of the need of constant vigilance has been found effective training. Drivers are instructed that they must know their vehicle and what it can do, and that it is their duty to keep it out of accidents because they are professional drivers. They are told to extend the courtesies of the road and the right of way to non-professional drivers, who become confused and do not know what to do in emergencies; further, that they must make a business of driving and focus their entire attention upon it, avoiding unnecessary conversation with passengers, and must only answer questions referring to their fares. This refers especially to motorcoach and taxicab drivers.

Payment of Drivers

Drivers are paid by the hour, week or month. If paid by the hour, the rates are from 50 cents to $1, depending on the location and the kind of service they are rendering. The guaranteed minimum varies from $100 to $150 per month. Long-distance stage companies pay the highest wages.

It is poor economy to try to save on the driver's wages. The higher the wages which are paid, the higher will be the type of the men in the service. Some companies pay a bonus based upon the amount of work done; others pay a bonus if the drivers are able to avoid accidents.

SAFETY MEASURES

Motor-vehicles should be kept in good operating condition at all times.

This refers especially to the brakes, steering-gear, tires and the like. The comfort of the driver must also be given proper attention, because uncomfortable seats, cabs that cannot be closed in severe weather, and long hours cause undue fatigue, which greatly increases the likelihood of accidents. The safety measures advocated or tried and found more or less satisfactory in the elimination of accidents can be summarized as follows:

(1) Each accident, however small, must be investigated strictly

(2) Penalties must be assessed when accidents are caused by the driver

(3) Posting records of accidents: This includes accidents to other persons and property, as well as to the company's property, and draws attention daily to accidents.

(4) Stimulating rivalry among drivers to avoid accidents

(5) The system of merits and demerits; wage increase, taking cognizance of accidents caused by the driver; contests and prizes given for freedom from accidents

(6) Periodic talks, by higher officials, on safety measures

(7) Observance of rules; drivers must pay their own fines for speeding

(8) Supervision; checking speed and recklessness of drivers

(9) The employer's duty to his men

(10) Educating school children and the public in general in accident prevention

When the driver knows that every accident is investigated strictly by the company, he will be more vigilant. He will be careful in ordinary traffic not to hit another vehicle, and will take precautions to avoid being hit by others. He knows that, by following the rules of the road, giving the proper signals and watching the signals ahead of him, most minor accidents in which fenders or bumpers are bent or damaged can be avoided. He will automatically become alert to keep free from accidents.

A complete record of the types of accident, as well as the number of accidents which each driver has, is kept on file. With a number of companies, the driver meets a committee which has investigated the accident and which makes a report on it in his presence. He is given the opportunity of explaining his side of the story. Usually a higher official is present who determines the responsibility at that time. It has been found advantageous to have on hand miniature models of vehicles and streets, which are used to determine the cause of an accident. Often a driver can illustrate exactly, by the movement of these toy machines, what actually occurred at the time of the accident.

Data Needed for Accident Reports

The form of accident report used by one motorcoach company states that the report must be filled out for any accident, either to person or property, however slight the injury or damage may appear, and that every accident causing real or alleged injury to a passenger or serious personal injury to any other person must be reported immediately by telephone to the company's dispatcher. The instructions are to obtain names and addresses of all witnesses, both on the coach and in the street, and that the original writing of names and addresses of witnesses must accompany the report. A separate report is required from each employe who witnessed the accident, whether his coach was involved or not. The data required and the questions to be answered are given at the bottom of this page.

Penalties Assessed Against Driver

If, upon strict investigation, it has been found that the driver was to blame for the accident or even partly blamable for it, penalties are assessed in accordance with his carelessness, weight being given to whether it was due to violation of any rules. In some cases the penalty is dismissal. In most cases, however, the driver is penalized in other ways; he may be laid off from three to six days or longer. Many companies claim that it is useless to discharge a driver for accidents until all other methods have been tried to make him a safe driver. This does not mean that a careless or reckless driver is retained in service; such a man is discharged; but it refers to accidents caused by inattention, which is the cause of the greatest number of accidents.

Some corporations appoint a committee of employes which sits as a body and considers every report of each accident in which a company vehicle is concerned. The committee carefully studies the cause of the accident by means of miniature automobiles, reproducing the exact conditions surrounding the accident. The employes who are sitting on this committee are imbued with the importance of their work and that is their duty to lay the blame wherever it falls.

Drivers are trained and instructed not to place the responsibility for an accident on the owner or driver of a privately owned automobile with a view of receiving extra consideration

Accident Data Required by One Motorcoach Company

Date of accident
Time
Division
Line No.
Coach No.
Direction
Exact place of accident shown on a diagram
How far was coach from right-hand curb?
How far from nearest cross-walk?
Condition of weather?
Was street wet or dry?
Any defects in pavement?
Headlights burning?
Tail-light burning?
Inside lights?
Any unusual jerk or movement of coach?
Was horn sounded?
Was person warned of danger?
How far did coach move after accident?
Condition of brakes: foot; hand
Was the person injured or the driver of the other vehicle negligent in any manner?
In what way was he negligent?
How fast was coach moving when brakes were applied to avoid accident?
How far were you then from point of impact?
How fast was coach moving at time of impact?
How far did coach move after collision?
How fast was the other vehicle moving when first seen?
How far was it then from point of impact?
How fast was the vehicle moving at time of impact?
Did you apply brakes as soon as you saw the vehicle?
License number of other vehicle
Name of driver of other vehicle
Address of driver of other vehicle
Names and addresses of persons concerned: State whether in coach, automobile, or where
Nature of injury
What was done with injured persons?
If an employe, show age and whether married or single
Damage to coach
Damage to other property
Did you see accident?
How many passengers on coach? Upper deck; inside
Were any passengers standing?
How many?
Were any passengers thrown down in aisle or out of their seats?
How many names of witnesses are you sending in with this report?
Name of operator and Badge No.
Name of conductor and Badge No.
Date this report was made out
Sign your name here
A separate report must be made by operator and by conductor
In addition to answering the above questions, give a full account of the accident in the space provided.

from the committee for that cause. Making drivers pay for damages resulting from accidents due to their own negligence has led to a reduced number of accidents in many cases.

Posting Record of Accident

This includes accidents to other persons and property as well as to company's property. Posting a record of each accident of all the drivers draws every driver's attention to accidents and impresses vigilance automatically; besides, the driver feels humiliated by having his accidents posted on the bulletin board; it is a great stimulus for him to try to avoid accidents in the future. With each accident the man's accident record is checked and brought to his attention with a view to keeping before him the number and types of accidents he has had, and he is admonished by his chief to be more careful. A bulletin also shows the monthly record of all accidents and the total number of accidents of the entire system, the name of each man involved and whether he was charged with responsibility.

Stimulating Rivalry

Some companies have found that considerable rivalry resulted from the posting of all the accidents on their lines. As a result, drivers often work for an entire year without the slightest accident either to passengers or to vehicle.

In most cases, stimulating rivalry for freedom from accidents is beneficial and, where the drivers are properly selected and trained, it is found that in almost all cases of accident the driver of the privately owned automobile is at fault, and that the company driver who is constantly trained and educated to avoid accidents is showing the result of that training by having very few accidents. Very often, in case of accident, the trained operator will prevent a greater accident by his knowledge of accident prevention. However, there is a difference of opinion as to whether the rivalry to prevent accidents always produces the desired results in other respects. A man may become so careful in driving as to waste a great deal of time and, as a company executive views truck operation from the main standpoint of dollars and cents, sometimes the loss of time by a driver will be so great as to classify him as inefficient for the work he has to do, which is another reason why quickness of judgment and coordination between mind and body should play an important part in the selection and examination of drivers.

The Merit System

The bonus system, as well as contests and the giving of prizes for safe driving, has been found advantageous by many companies; others oppose it. All agree, however, that constant training of the employe, constantly drawing accidents to his attention and educating him in accident prevention, accomplish excellent results. A number of companies which do not pay bonuses for safe driving generally take cognizance of freedom from accidents and grant salary increases when warranted by the record as to the driver's ability, general efficiency and freedom from accidents.

In the merit system as used by some of the railroads, a man is given a rating of merits and demerits in accordance with his work. When a man violates a rule or has an accident that was avoidable, it is marked up against him on the record, and these demerits usually cover the semi-minor offenses. At the end of the year, the man will automatically discharge himself if the number of demerits marked up against him reaches a certain figure. In some companies the demerits will wipe out the credits, and vice versa; that is, credits accumulated through avoidance from accidents over a given period or from excellent service in other respects. Some companies find that this system, which works satisfactorily with the railroads, does not work so well with motor-vehicle operation; so they have combined some of the better features of this system with their own method, such as penalizing the men for accidents by laying them off without pay for from one to ten days, depending on the seriousness of the fault.

It is important that companies take extra precaution to be absolutely just, and not to blame their driver when the evidence shows that he could not be blamed in any respect. Some companies automatically discharge a man if he has a certain number of accidents during any one year in which the fault has been found to lie with him. This system seems to work exceedingly well, for when men know that if they have, say, three accidents in a year they will be discharged, they make extra efforts to be careful and to avoid accidents.

Employes are told also that, before any wage increase is given, their record as to accidents is investigated. This has a beneficial effect upon them.

It is found in some cases that a man may be an excellent driver and is trying to do his best, but is not fitted for the special type of equipment he is handling. In such a case he is transferred to other work more suited to him. Driving may be too nerve-racking for him, and all the companies are recognizing the importance of keeping men in their services and reducing the labor turnover, which is found wasteful by all.

The excuse offered by some drivers that they had the right-of-way in cases of accidents is rarely considered; a careful driver must consider not only his own right-of-way, but that of the other machine, and must anticipate what the driver of another car will do. Some companies find that fear of being penalized or expectation of reward is less important than educating the man to the responsibility resting upon him and imbuing him with his importance in having charge of a valuable piece of equipment which can be damaged to a considerable extent and do harm to others unless properly handled. Men should be stimulated to take pride in their work, in knowing how to drive safely and how to avoid accidents, to respect themselves as well as others, and to consider the rights of others.

Some companies' drivers are allowed to choose the runs on their motorcoach or motor-truck lines, as the case may be, in accordance with the merit marks they have earned during a certain period; for instance, three months. This in an inducement that is appreciated by a number of men, as they prefer to drive in certain districts rather than in others.

Talks on Safety Measures

Companies find that frequent meetings of some of the executives or the management with the drivers and the helpers establish a closer personal contact with the men and have very beneficial results. Other concerns educate their drivers and maintain close contact between the management and the men by direct mail, and this too has been found of value in some cases.

The driver is drilled in protective measures for the property entrusted to him, and in his duty of avoiding accidents and damage to the equipment. It should be instilled into drivers that although an accident may seemingly be unavoidable, in most cases it can be seen after the accident what could have been done to avoid it. When the drivers recognize the seriousness of the problem of accident prevention and the genuine efforts made by the executives in educating them in the accepted rules of accident prevention, it has a beneficial effect, because they feel their responsibility and their importance in the machinery of the corporation.

Observance of Road Rules

Corporations make it a point that their drivers must observe the traffic laws, and that they must be courteous to other drivers on the road and give them the right-of-way when they are entitled to it; further, that they must yield the right-of-way to other drivers even when they are not entitled to it, if there is the slightest possibility of an accident. Some companies go even further; they find that extending to others the courtesies of the road makes for public good-will toward the corporation which employs the drivers. The drivers must comply with all the laws

regarding speeding and overloading.

A number of companies make their drivers pay their own fines for speeding and overloading, and this has been found to have a very beneficial effect. Reckless drivers are not retained in the service of any company. Men are required to cooperate with the police department in every possible way, and to follow their instructions and the directions of the traffic officer even if they do not agree with the officer's ruling at the time. This refers especially to motorcoach drivers, who find that, by keeping in close touch with the police department, operating conditions are made easier and better service is obtained.

Checking Over-Speeding and Recklessness

Some companies endeavor to check over-speeding and recklessness of their drivers by having a supervisor follow them on their runs occassionally. This is found to have a beneficial effect, because the men never know when one of the company's supervisors is following or watching, and this is an added reason why they should endeavor at all times to drive within the speed laws and with due care for the rights of others.

With motorcoach companies, supervision sometimes extends to the checking of the manner of treatment accorded the passengers by the drivers. This is at times done in the open and at other times under cover, according to the information the company wishes to acquire. Some truck companies also check the deliveries made by their men to see that they do not loiter on the route.

Employer's Duty to His Men

The duty of a corporation employing drivers is, first, to see that the vehicle is in good working order, that the brakes are effective, that the men are not permitted to drive a vehicle when the driver's report shows that the brakes are not in good order, that the driver's seat is comfortable, and that the driver is protected from inclement weather. If vehicles must be driven in rain and in cold weather, the driver should be protected from the elements without obstructing visibility in front or on either side. When a driver has to fight the elements, when he is cold or is being drenched by rain, his attention cannot be focused with sufficient alertness on the work he is performing.

The custom of some of the smaller trucking companies of demanding that the men make certain deliveries in outlying districts or a certain number of deliveries daily, which cannot be done without exceeding the speed limit, is very reprehensible. In some cases the deliveries cannot be made in the hours that the man is at work unless the speed laws are broken. When a man has an accident under such conditions, the blame rests largely with the employer.

Unfortunately, in some States, the speed limits for heavy-duty trucks on solid and on pneumatic tires are unduly low; for this reason it is acknowledged that everyone exceeds the speed limit with such vehicles. In certain States, counties and cities the officers try to enforce the speed laws; in others they do not, especially when they recognize that everyone is breaking the law. This is a difficult situation to correct, but it will have to be solved by increasing the speed limit to the point at which the vehicle can be operated safely, and, in view of the increasing use of pneumatic tires and the increased efficiency of brakes, the present speed limits for these vehicles should be increased.

Another duty of the employer is to let the men know that he, or the higher executives of a corporation, as the case may be, are taking an interest in the welfare of the men; that they recognize their problems and the driver's viewpoint, and that they all are personally interested in accident prevention as well as in reducing the cost of transportation. If the higher officials occasionally talk to the drivers, imbue them with their own views and make them feel that they take an interest in the driver's work, it will greatly assist in the prevention of accidents and lessen their number.

It undoubtedly is true that in many cases personal injuries and fatal accidents would not occur if pedestrians used ordinary care. With this end in view, educating the school children and the public in general in accident prevention will produce very beneficial results. In every school a few minutes can be spent once a week in talking "accident prevention." The need should be impressed upon everyone of looking for approaching vehicles before stepping off the curb and when crossing street intersections, and of obeying the rules of the communities which prohibit jay-walking. By constantly educating everyone in accident prevention, the dreadful toll of life can be reduced to a negligible amount.

Labor Turnover Important

It is felt that the measure of success in the selecting, training and handling of drivers, as well as in the operating safety measures, is the labor turnover. Experience has shown that the greatest turnover usually occurs during the first three months of employment, which seems to indicate that the men selected either have not the proper qualifications or are not of the proper type for the work. Wherever the turnover is low, accidents are fewer in number. Increased turnover usually means an increased number of accidents.

Suggested Committee Work

It seems that the most profitable committee work to be done on this subject is to study the best methods, or to devise new methods, for the selection of drivers. This should take cognizance of the difference between the types of men required for different classes of service and the best methods for determining, during their selection, whether they will make satisfactory drivers. The more thorough and satisfactory the selection is, the smaller will be the turnover, the more efficient will be the work rendered by the men, and the smaller will be the number of accidents.

Ethelbert Favary,
Chairman.

Interesting Transportation Papers

An interesting paper entitled Problems of Motorcoach Design and Manufacture, by G. A. Green, vice-president in charge of engineering for the General Motors Truck Corp., Pontiac, Mich., is printed in full in this issue, beginning on p. 166. It contains numerous suggestions for motorcoach improvement, and is stimulating in character owing to the suggestions made regarding the possibilities of radical departures from present practices.

In this issue also will be found, beginning on p. 161, the discussion of the paper on Short-Haul Passenger Transportation which was presented by A. T. Warner at the 1928 Transportation Meeting and printed in the November, 1928, issue of the S.A.E. Journal, beginning on p. 447. This completes the publication of both the long-haul and the short-haul phases of motorcoach operation which were presented at that meeting, the paper on Long-Haul Passenger Transportation, by W. E. Travis, having been printed in the January, 1929, issue beginning on p. 61. Some of the points criticised in the discussion now published refer to inadequate ventilation, uncomfortable seats, exhaust fumes in the body, noisy exhausts, and swaying hold-on straps for standees. Problems of seating arrangement in city-type coaches, of taxicab and jitney competition, route designation, and tire equipment are considered also.

Although the paper by L. A. Baron, entitled Accounting for Depreciation as a Production Cost, p. 126, may seem not to have a direct bearing on transportation, it is believed that a careful reading of it will make it evident that at least some of the fundamentals of accounting for depreciation as stated in the paper will be helpful in promoting a better understanding of depreciation as applied to fleet operation.

Standardization Activities

Balloon-Tire Sizes Revised

Two Sizes Eliminated from Standard List and One Size Added to Division

At a meeting of the Tire and Rim Division, held in Detroit on Jan. 17, the question of further balloon-tire standardization and simplification was considered.

The question of marking tires for balance was discussed at a meeting of the Tire Steering Committee, held in December, and a questionnaire was outlined which was later sent to the motor-car companies to determine the most acceptable method for so marking tires.

The results of this questionnaire indicated that, of 36 companies, 34 were willing to accept a marking consisting of a red dot or a 1/4-in. square on the serial-number side of the casing, just above the rim flange, to indicate the valve location. As this method is in rather general use and is so overwhelmingly favored, it was deemed advisable to approve this method of marking as part of the present S.A.E. Standard on balloon tires and rims. Therefore the Tire and Rim Division will submit to the Standards Committee for approval the recommendation that the following note be added to the present specifications:

Note.—Tires shall be marked for balance by means of a red dot or a ¼-in. square on the serial side of the casing just above the rim flange.

One of the primary purposes of the meeting was to discuss possible elimination of the 4.75 and 5.25 cross-sections of tires from the present standard. In discussing the elimination of the 4.75-20, it developed that this size is considered the logical oversize for the 4.50-20 and therefore that, until further developments occur, this size should be retained.

Sizes 4.75-19 and 5.25-18 Deleted

Consideration was then given to the elimination of the 4.75-19 size and it was decided that, as there is virtually no use for this size as original equipment and it is not in use as an oversize, it can be discontinued without causing dissatisfaction. Therefore, the elimination of the 4.75-19 size was approved by the Division.

The question of deleting the 5.25-18 tire from the table also was discussed and, while tires of this size are original equipment on one of the well-known cars, it was felt that, in view of the possibility of a change in tire equipment by this manufacturer, the 5.25-18 size could also be eliminated, and it was so voted.

The 5.25-19 size was retained, after some discussion, as an oversize for the 5.00-19, although it is not in general use as original equipment.

A 7.00-19 Size Added

To provide a suitable oversize for the 6.50-19, and because of the probability of the adoption of this size by one or more manufacturers of large cars, it was decided to include in the table a 7.00-19 tire.

The complete revised specification, including the note on marking tires for balance, mentioned above, as it will be presented to the Standards Committee at the Summer Meeting in June, is given in the accompanying table.

Split and Tubular Rivets

Complete Dimensional Specifications and Tolerances for Each Type Approved by Subdivision

The present specifications on split and tubular rivets, as shown in the 1928 Edition of the S.A.E. Handbook, were brought up for revision by the Subdivision on Split and Tubular Rivets that is formulating the original specifications. So that the specifications shall be of any value to the user of rivets, it was found necessary to add dimensions and tolerances to provide a complete set of dimensions for each type of rivet. The matter was left to

BALLOON TIRES AND RIMS

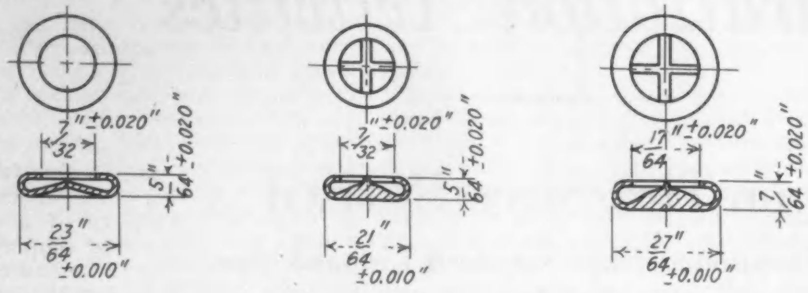
	Tire Sections							
Rim Diameter	4.50	4.75	5.00	5.25	5.50	6.00	6.50	7.00
18					5.50-18 (*28x5.50*)	6.00-18 (*30x6.00*)	6.50-18 (*30x6.50*) (*30x6.20*)	7.00-18 (*32x7.00*) (*30x6.75*)
19			5.00-19 (*29x5.00*) (*28x4.95*)	5.25-19 (*29x5.25*)	5.50-19 (*29x5.50*)	6.00-19 (*31x6.00*)	6.50-19 (*31x6.50*) (*31x6.20*)	7.00-19
20		4.75-20 (*29x4.75*)	5.00-20 (*30x5.00*) (*29x4.95*)		5.50-20 (*30x5.50*)	6.00-20 (*32x6.00*) (*30x5.77*)	6.50-20 (*32x6.50*) (*32x6.20*)	7.00-20 (*34x7.00*) (*32x6.75*)
21	4.50-21							
Rim-Section Width,[1] In.	2.75 Flat Base or Drop	4	4	4	4	4½	4½	5
Maximum Tire Width on Rim, In.	4.75	4.85	5.15	5.35	5.60	5.95	6.40	6.90

[1] Rim widths given are nominal except the 2.75-in. size, which dimension is the actual width between flanges.

Method of Marking.—**Tires shall be marked with the tire cross-section followed by the rim diameter on which** the tire shall be used; under which designation shall be placed, in small figures, the former name-size or sizes of the tires replaced.

Marking for Balance.—Tires shall be marked for balance by means of a red dot or a ¼-in. square on the serial side of the casing just above the rim flange.

RIVET CAPS



For Use with Split Rivets and Wrought Iron Tubular Rivets

For Use with Steel and Brass Tubular Rivets

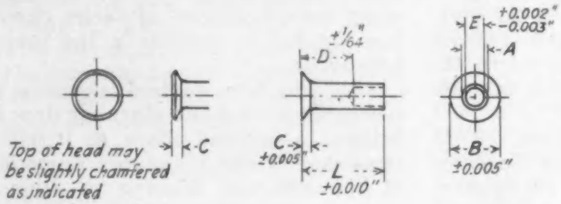
a committee of the rivet manufacturers to submit a proposal for the consideration of the Subdivision after the manufacturers' committee had discussed the general manufacturing practice in such matters as the wire sizes, body diameters and tolerances.

This proposal was sent out to the motor-car and the rivet manufacturers for comment and was then made a subject of discussion at a Subdivision meeting held in Detroit on Jan. 14.

The accompanying illustrations and tables represent the proposed revision. No mention is made in the specifications of the tolerance permitted on eccentricity of the bore in tubular rivets. This question is to be made the subject of further study by the manufacturers' committee and definite tolerances are to be presented to the Subdivision for future consideration.

Note.—Radii under the head of rivets shall not exceed the following: For rivets under 1/8-in. body diameter, radius 0.005 maximum; for rivets over 1/8-in. and under 9/64-in. body diameter, radius 0.010 maximum; for rivets over 0.65-in. and under 3/16-in. body diameter, radius 0.015 maximum.

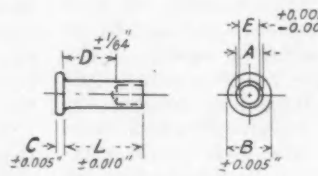
FLAT COUNTERSUNK-HEAD TUBULAR RIVETS



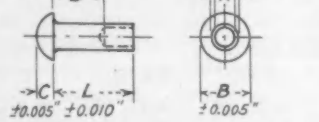
NOMINAL DIAMETER	A	B	C	D	E	L
1/8	0.123±0.003	1/4	1/32	L − 5/32	0.086	1/4 to 1/2 by 1/32
9/64	0.145±0.003	5/16	3/64	L − 1/8	0.098	1/4 to 5/8 by 1/32
9/64	0.145±0.003	5/16	3/64	L − 3/16	0.098	1/4 to 5/8 by 1/32
9/64	0.145±0.003	5/16	3/64	DRILLED TO HEAD	0.098	5/16 to 1/2 by 1/32
3/16	0.186±0.005	3/8	3/64	L − 1/8	0.133	1/4 to 3/4 by 1/32
3/16	0.186±0.005	3/8	3/64	L − 3/16	0.133	1/4 to 3/4 by 1/32
3/16	0.186±0.005	3/8	3/64	DRILLED TO HEAD	0.133	5/16 to 1/2 by 1/32

***Note**: The above specifications are for steel and brass rivets for a roll clinch; where star clinch or wrought iron rivet is used, the drill size should be 0.006 in. larger*

FLAT-HEAD TUBULAR RIVETS

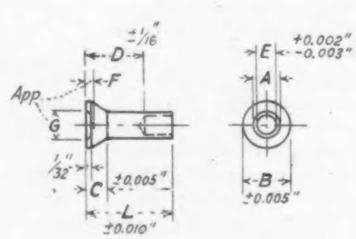


NOMINAL DIAMETER	A	B	C	D	E	L
1/8	0.123±0.003	1/4	0.020	L − 1/16	0.086	3/32 to 3/8 by 1/32
9/64	0.145±0.003	5/16	3/64	L − 5/32	0.098	3/16 to 5/8 by 1/32
3/16	0.186±0.005	7/16	1/16	L − 3/16	0.133	1/4 to 5/8 by 1/32



NOMINAL DIAMETER	A	B	C	D	E	L
1/8	0.123±0.003	7/32	1/32	L − 1/16	0.086	3/32 to 5/8 by 1/32
9/64	0.145±0.003	5/16	3/64	L − 1/8	0.098	3/16 to 5/8 by 1/32
9/64	0.145±0.003	5/16	3/64	L − 3/16	0.098	1/4 to 5/8 by 1/32
9/64	0.145±0.003	5/16	3/64	L − 1/4	0.098	5/16 to 5/8 by 1/32
3/16	0.186±0.005	3/8	1/16	L − 1/8	0.133	3/16 to 3/4 by 1/32
3/16	0.186±0.005	3/8	1/16	L − 3/16	0.133	1/4 to 3/4 by 1/32

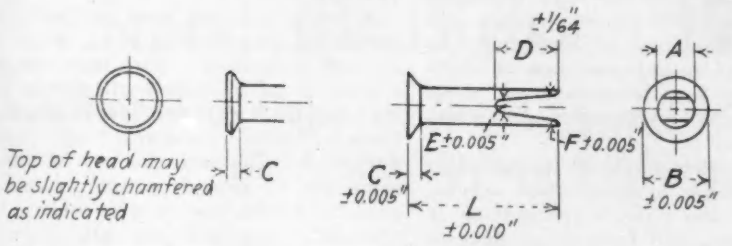
OVAL-HEAD TUBULAR RIVETS



NOMINAL DIAMETER	A	B	C	D	E	F	G	L
9/64	0.145±0.003	5/16	7/64	L − 1/8	0.098	3/64	1/4	9/32 to 5/8 by 1/32
3/16	0.186±0.005	3/8	1/8	L − 5/32	0.133	1/16	19/64	9/32 to 5/8 by 1/32

CUPPED COUNTERSUNK-HEAD TUBULAR RIVETS

FLAT COUNTERSUNK-HEAD SPLIT RIVETS



Nom. Diam.	A	B	C	L	D	E	F
1/8"	0.122 ±0.005	7/32	1/32	1/4	5/32	0.040	0.047
	0.122 ±0.005	7/32	1/32	5/16	7/32	0.040	0.052
	0.122 ±0.005	7/32	1/32	3/8	9/32	0.040	0.057
	0.122 ±0.005	7/32	1/32	7/16-1/2	5/16	0.040	0.057
3/16"	0.190 +0.010 −0.005	7/16	3/64	5/16	7/32	0.065	0.120
	0.190 +0.010 −0.005	7/16	3/64	3/8	9/32	0.065	0.125
	0.190 +0.010 −0.005	7/16	3/64	7/16	5/16	0.065	0.127
	0.190 +0.010 −0.005	7/16	3/64	1/2	3/8	0.065	0.130

NOTE: Lengths increase in 1/16" steps

Nominal Diameter	A	B	C	L	D	E	F
9/64"	0.146 ±0.005	5/16	3/64	1/4	5/32	0.050	0.060
	0.146 ±0.005	5/16	3/64	5/16	7/32	0.050	0.073
	0.146 ±0.005	5/16	3/64	3/8	9/32	0.050	0.078
	0.146 ±0.005	5/16	3/64	7/16	11/32	0.050	0.081
	0.146 ±0.005	5/16	3/64	1/2	11/32	0.050	0.083
	0.146 ±0.005	5/16	3/64	9/16-3/4	13/32	0.052	0.077
	0.146 ±0.005	3/8	3/64	1/4	5/32	0.050	0.060
	0.146 ±0.005	3/8	3/64	5/16	7/32	0.050	0.073
	0.146 ±0.005	3/8	3/64	3/8	9/32	0.050	0.078
	0.146 ±0.005	3/8	3/64	7/16	11/32	0.050	0.081
	0.146 ±0.005	3/8	3/64	1/2	11/32	0.050	0.083
	0.146 ±0.005	3/8	3/64	9/16-3/4	13/32	0.052	0.077

Roller-Chain Standards

IN December, 1926, the Sectional Committee on Standardization of Power-Transmission Chains and Sprockets organized a Subcommittee to review the standards for roller chains that had been formulated and issued for several years by the Society and the American Society of Mechanical Engineers. It had been hoped that the former standards, that included light, medium and heavy-duty series of chains, would come into general use, but only one of them was actually adopted in practice.

The Subcommittee, after making a careful study of commercial requirements and practices in the use of roller chains and holding a series of meetings, submitted its report to the Sectional Committee at a meeting held in New York City on Jan. 8. A few modifications in the data submitted were suggested and, as soon as these have been worked out by the Subcommittee, the report probably will be published in more or less complete form in an early issue of THE JOURNAL.

The report includes a section on standard nomenclature for the various chain parts and also dimensions for a standard and for an extra-heavy series of chains that are the same except for the thickness of the inside plate. The basic formulas for determining the sizes of the several chain parts are given, as are also tables intended as general information on working loads and horsepowers. The report also includes formulas and tabulated dimensions for sprockets and information regarding what is considered good roller-chain power-transmission practice, together with data for special applications such as metal patterns for cast sprockets.

Although the use of roller chains on motor-vehicles is rather limited, it is growing in industrial power-transmissions, and it is hoped that the standard when completed and published will be of substantial benefit to the chain manufacturers and users.

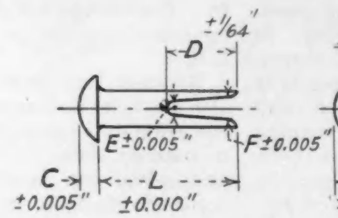
A similar program is in progress for the so-called silent type of chains.

Transmission Oil Classification

WHAT are the factors in service that determine the desirable properties of transmission lubricants and how can these factors be measured? was the general subject for discussion at a meeting of the Lubricants Division held on Jan. 15 in Detroit.

On account of the widespread adoption of the crankcase lubricating-oil viscosity numbers, several requests have been made for a like classifying of transmission lubricants. The problem is necessarily more complicated in

OVAL-HEAD SPLIT RIVETS



Nom. Diam.	A	B	C	L	D	E	F
3/32"	0.086 ±0.005	9/64	0.025	3/16	5/32	0.030	0.037
	0.086 ±0.005	9/64	0.025	1/4	7/32	0.030	0.039
	0.086 ±0.005	9/64	0.025	5/16	9/32	0.030	0.039
	0.086 ±0.005	9/64	0.025	3/8-1/2	5/16	0.030	0.039
1/8"	0.122 ±0.005	7/32	1/32	3/16	5/32	0.040	0.047
	0.122 ±0.005	7/32	1/32	1/4	7/32	0.040	0.052
	0.122 ±0.005	7/32	1/32	5/16	9/32	0.040	0.057
	0.122 ±0.005	7/32	1/32	3/8-3/4	5/16	0.040	0.057

NOTE: Lengths increase in 1/16" steps

Nom. Diam.	A	B	C	L	D	E	F
9/64"	0.146 ±0.005	5/16	3/64	3/16	5/32	0.050	0.060
	0.146 ±0.005	5/16	3/64	1/4	7/32	0.050	0.073
	0.146 ±0.005	5/16	3/64	5/16	9/32	0.050	0.078
	0.146 ±0.005	5/16	3/64	3/8	11/32	0.050	0.081
	0.146 ±0.005	5/16	3/64	7/16	11/32	0.050	0.083
	0.146 ±0.005	5/16	3/64	1/2-3/4	13/32	0.052	0.077
3/16"	0.190 +0.010 −0.005	11/32	1/16	1/4	7/32	0.065	0.120
	0.190 +0.010 −0.005	11/32	1/16	5/16	9/32	0.065	0.125
	0.190 +0.010 −0.005	11/32	1/16	3/8	5/16	0.065	0.127
	0.190 +0.010 −0.005	11/32	1/16	7/16	3/8	0.065	0.130
	0.190 +0.010 −0.005	11/32	1/16	1/2	7/16	0.068	0.133

that both greases and straight petroleum oils are used as transmission and rear-axle lubricants, and a considerable difference of opinion exists as to the correct method of classification.

It is to be remembered that the aim is not to write a purchasing specification but to provide a grading which will enable automobile manufacturers to recommend to the automobile owner the proper type or grade of lubricant without the necessity of using trade names.

The Division was in agreement that the best method of procedure was to collect and correlate with measurement methods existing data on the factors in service which determine a proper transmission and rear-axle lubricant. These factors include lubrication of all parts of the unit, including bearings; no pronounced increase in volume by foaming or frothing; no separation of ingredients; ease of shifting gears at low temperatures; noise reduction; and no transmission or rear-axle leakage.

The next step would be to establish the relationship between these service factors and the physical properties of the lubricants, and from these data to work toward a reasonable classification. The program is extensive and the problems are difficult, but, with the spirit of cooperation shown between the technical men of the two industries represented on the Division, these problems are capable of solution.

Aeronautic Standardization

Progress Reports Presented by Aeronautic Division at Standards Committee Meeting in Detroit

MUCH of the standardization work in progress by the Aeronautic Division of the Standards Committee consists of a number of important projects as well as others having to do mainly with detail dimensions.

Axles, Wheels and Tires

One of the projects receiving considerable attention is axles, wheels, rims and tires for airplanes. At the meeting of the Standards Committee in Detroit on Jan. 15, Henry F. Schippel, of the B. F. Goodrich Co., reported that plain bearings for wheels with and without brakes, together with bearing dimensions and tolerances, have been worked out in practice, but that the Army is not ready to adopt any standards for anti-friction bearings. He stated that a committee has been appointed to work this out, because designs have already been prepared for bearings for wheels to take 30 x 5-in. tires and larger sizes.

Wheel standards for radial and lateral strengths have been set up which will be the same as those adopted by the Army and Navy in their specifications, as the Army and Navy are represented on the Committee. Mr. Schippel stated that the Committee is trying to develop standards that can be the same for the S.A.E. and the Government services. Wheel-weight standards are being worked out which will agree with the Army and Navy standards, while in connection with rims for airplane wheels there has been considerable discussion in the Tire and Rim Association meetings and elsewhere of the desirability of interchangeability of airplane and passenger-car tires. It has been virtually decided, however, that such interchangeability is not desirable because of changes that would have to be made in the present airplane rim standards. The standards on width between rim flanges have been changed so that, with the oversize tire mounted on any particular rim, the rim width is 50 per cent of the tire width. This holds true, said Mr. Schippel, through the entire range of standard tire-sizes from 28 x 4 up to 54 x 12 in. Rim-flange heights are still under consideration for the 6-in. tire size and larger.

As there has been much confusion in the past in the matter of numbering the rims or wheels, it has been decided to number them by the nominal size of tires which are mounted on them.

Standards have been worked out for cross-section and over-all diameters of standard and oversize tires. These dimensions are the same as those developed more than a year ago by the Tire and Rim Association and will be incorporated in the standard with slight modifications in cross-sectional width due to some change in the width between flanges of the rim. Standards that have been developed for load and inflation pressures are also subject to modification due to changes in the rim widths. Maximum weights to be adopted are being worked out for a common standard between the S.A.E., the Army and the Navy. The oversize tires on any size of rim or wheel are to be rated at normal load-carrying capacity, the purpose of oversizing tires being to improve the cushioning and landing conditions on soft fields and not for the carrying of extra loads. This was particularly requested by the wheel manufacturers because they have some trouble with flanges and wheels buckling under the greater load being carried in present oversizing practice.

A 16-in. rim has been decided upon, giving the standard of 8, 12, 16 and 20-in. rim diameters. Tire-tube weights are being set up which will agree with the revised Army and Navy specifications. Valve standards are being drafted to eliminate the use of extensions and to provide proper mounting conditions with disc or wire wheels. A spreader, standard for all sizes of tubes, has been developed to provide better mounting conditions for the valves. The chemical requirements for tire tubes are being revised considerably to bring them uptodate and to conform to the proposed revision of Federal Specification 3-C, which is now under revision by the Technical Committee of the Rubber Association of America.

Airplane Landing-Lights

Another important project is a study of landing-lights on airplanes, on which Carl V. Johnson reported that the work of the Aircraft Lighting Committee has not progressed sufficiently to make a definite report other than on a few things the Committee contemplates accomplishing. He stated that the aircraft-lighting problem is very dissimilar to that of any other fields, but is perhaps most closely allied to motor-car lighting. One of the differences, however, is that pilots cannot replace lamps when they burn out in the air, as can the motorist. Moreover, a car traveling at 40 m.p.h. is speeding, whereas airplanes land at a speed of 40 m.p.h., which fact, together with other factors such as weight of equipment and head resistance, make it necessary to give the subject careful study.

In starting to work out this problem, six airplanes, three in the passenger and mail service, one in passenger service, one in the Army, and one in the Navy, have been equipped experimentally with various kinds of spreading lamp-lenses, bulbs and wiring arrangements. It may be possible to arrive at some conclusion within a relatively short time on the minimum lighting requirements on airplanes for emergency landings, and from these a committee will try to work out standards for equipment and the proper shielding of wires to prevent interference with the inductor compass and radio equipment on the airplane. The work also involves storage batteries and generators, and it probably will be a year before the Committee can get unanimity of opinion on suitable standards among the various factors in the industry. The emergency landing-lights on airplanes probably will be the prime consideration, although navigation lights, instrument lights, cabin lights, and so forth will also be considered.

Standards Division Reports Approved

Twenty-Seven Reports, Acted Upon by Standards Committee, Members and Council, Now Submitted to Letter-Ballot

TWENTY-SIX reports of the Standards Committee Divisions that were published in the January issue of THE JOURNAL, pp. 73 to 87, were submitted and approved at the meeting of the Standards Committee in Detroit on Tuesday morning, Jan. 15, at which Vice-Chairman A. J. Scaife presided. One additional report recommending concellation of the present S.A.E. Recommended Practice for Engine-Bed Timbers, p. 42 of the 1928 edition of the S.A.E. HANDBOOK, was also submitted by the Motorboat and Marine Engine Division and approved. The reports were submitted by the Aeronautic, Agricultural Power Equipment, Axle and Wheels, Electric Vehicle, Electrical Equipment, Lighting, Lubricants, Motorboat and Marine Engine, Motor-Truck, Passenger Car, Production, and Transmission Divisions.

In a few of the reports, slight revisions were made in numerical values that it was thought should be changed because of action taken since the reports were published or as a result of discussion at the Standards Committee meeting.

The action taken by the Standards Committee on the several reports was reviewed and approved at the general Business Session on Tuesday afternoon as well as by the Council of the Society at its meeting immediately thereafter. The reports are listed herein by title, together with their status and the principal discussion on each. The page reference given for each report indicates the page of the January issue of THE JOURNAL on which the report was printed.

LETTER-BALLOTS MAILED

The letter-ballot of voting members of the Society, as required by the Standards Committee Regulations and authorized by the general Business Meeting and the Council, has been mailed to the members and should be returned to the Society offices to be counted on Thursday, Feb. 21. Immediately thereafter the reports approved by letter-ballot will be prepared for printing in the 1929 issue of the HANDBOOK. The ballot provides for positive and negative votes and for waivers, so that members can vote for such reports as they feel qualified to vote on, waiving their votes on the others.

The Society's record shows that an average of only about 12 per cent of the voting members have returned standards letter-ballots heretofore. All members are urged to give this final step in this important work of the Society their careful attention and to return promptly their ballots properly marked. These reports were carefully prepared by qualified Committees and circulated widely for comment and approval by the industry in general before being submitted to the Standards Committee. Any negative votes should be cast because of general and not individual reasons, and all such negative votes must, if they are to receive serious consideration, be accompanied in writing by the reasons therefor.

Aeronautic Division

PROPELLER-HUBS AND SHAFT-ENDS

(Proposed Revision of S.A.E. Standard, p. 73)

THE DISCUSSION

ARTHUR NUTT[1]:—At the Aeronautic Division meeting in Chicago last December it was decided to reduce the diameter of the thread on the No. 40 shaft-end, which is the largest shaft in the list, to 2 13/16 in. Dimension *D*, which is the pilot size for the split cone, is 2.850 in. in the present standard, but it is believed now that this should be reduced to 2.812 in. so that it will have the same outside dimension as the thread and can be ground at the same time. As the cone that goes on the surface is split, this change should offer no difficulty in assembling and will make that particular thread size consistent with all the rest of the shaft-ends, which is in keeping with the purpose of standardization. It has likewise been suggested that the 2 3/8-in. thread on the No. 30 shaft be reduced to 2 5/16 in., which means that dimension *D* should be reduced to 2.312 in. All the members of the Division, I believe, are agreeable to these changes.

Shaft-ends Nos. 10 and 20 are not yet in general production except in engines that our company is starting to make. The thread sizes on these shafts should be 1 11/16 and 2 1/16 in. respectively, instead of 1 3/4 and 2 1/8 in., so as to be consistent with the other shaft-ends. Dimension *D* on shaft-ends Nos. 10 and 20 should be reduced to 1.687 and 2.062 in. respectively.

On shaft-end No. 30, dimension *B*, which is 2.411 in. maximum, is also inconsistent and it is suggested that this be reduced to 2.406 in. which, in the opinion of the Division members, will cause no difficulty and will give a little more clearance for dimension *S*, which is 2.414 in. Dimension *S* for the No. 10 shaft-end and hub should be 1.789 to correct a typographical error.

[This report was approved with these revisions.]

Agricultural Power-Equipment Division

TRACTOR POWER-TAKE-OFF SPEED

(Proposed Addition to S.A.E. Recommended Practice, p. 74)

Axle and Wheels Division

FRONT-AXLE HUBS

(Proposed Cancellation of S.A.E. Recommended Practice, p. 75)

THE DISCUSSION

F. G. WHITTINGTON[2]:—Has a rather careful survey been made to determine the reasons why this specification is not used? If a standard is not accepted by the industry, the reasons therefore would be a useful guide in furthering standardization work.

A. J. UNDERWOOD[3]:—At the time this specification was developed there was considerable discussion as to whether it should be adopted by the Society because it involves so much engineering opinion and design detail.

O. A. PARKER[4]:—The bearing sizes in this specification seem to have been well settled by standardization but there is a good deal of question regarding the specification that involves the position of the bearings on the spindles and their location with respect to the center line of the wheel, which is the real difficulty in trying to have such a standard.

Electric Vehicle Division

CHARGING PLUG AND RECEPTACLE

(Proposed Revision of S.A.E. Standard, p. 75)

[1] M.S.A.E.—Chief engineer, engine division, Curtiss Aeroplane & Motor Corp., Buffalo.

[2] M.S.A.E.—Chief engineer, Stewart-Warner Speedometer Corp., Chicago.

[3] M.S.A.E.—Standards department, Society of Automotive Engineers, New York City.

[4] M.S.A.E.—President, Parker Wheel Co., Cleveland.

Electrical Equipment Division

Starting-Motor Mounting

(*Proposed Revision of S.A.E. Standard, p.* 75)

Timer Distributors

(*Proposed Addition to S.A.E. Standard, p.* 75)

Rubber Bushings

(*Proposed Revision of S.A.E. Standard, p.* 75)

Generator Mountings

(*Proposed Addition to S.A.E. Standard, p.* 76)

Lighting Division

Head-Lamp Mountings

(*Proposed Revision of S.A.E. Recommended Practice, p.* 77)

Lamp Lenses

(*Proposed Revision of S.A.E. Standard, p.* 77)

THE DISCUSSION

MR. MICHEL:—The present standard in the HANDBOOK provides for only four sizes of head-lamp lens and, in view of recent changes in style and design of head-lamps, these sizes have become rather impractical and the limited number makes it impossible for the industry to follow the standard. The proposed revision includes the lens diameters from 8 to 13 in. in ¼-in. steps, which are sufficient to permit of the general use of the specification.

Tail-Lamps

(*Proposed Revision of S.A.E. Recommended Practice, p.* 76)

THE DISCUSSION

C. A. MICHEL[5]:—Up to the present there has been so much difficulty in meeting the existing specifications on tail-lamps that the industry has felt that revision of them is highly desirable. The present specifications are controlled largely by photometric requirements that are so sensitive and stringent in their detail that the slightest variation which would normally be expected in molten glass and in other details of manufacture may cause the rejection of a tail-lamp. It was therefore felt that the type of specification that has been approved by the Massachusetts Motor Vehicle Commission, which is largely a dimensional specification, would suffice and be preferable to the one which requires a somewhat complicated laboratory test.

Signal Lamps

(*Proposed Cancellation of S.A.E. Recommended Practice, p.* 77)

THE DISCUSSION

MR. MICHEL:—The present signal-lamp specification in the HANDBOOK involves very much the same conditions as that for tail-lamps, and the industry feels that to continue it is highly undesirable. It is therefore recommended that the proposed note be substituted in the HANDBOOK until a revised specification can be reported by the Division.

Lubricants Division

Crankcase-Oil Viscosity Numbers

(*Proposed Addition to S.A.E. Recommended Practice, p.* 78)

Motorboat and Marine Engine Division

Marine Shaft-Couplings

Marine Shaft-Ends

(*Proposed S.A.E. Recommended Practices, p.* 79)

THE DISCUSSION

MR. UNDERWOOD:—These reports should have been printed in the January issue of THE JOURNAL as being submitted for adoption as S.A.E. Recommended Practice rather than S.A.E. Standard.

MR. NUTT:—The recommendation for the shaft couplings includes "material—steel" which should not be specified, as the question of material should be left to the designer. Specifying the outside diameter at the end of the hub taper absolutely holds down the design to that proposed. It seems to me that the couplings should be made to fit standard shafts and this outside diameter omitted. A coupling hub with a large taper has less support on the small end, which is fundamentally poor design. This section of the hub should be thicker to withstand the larger expanding force that occurs when the coupling is forced on the shaft. These specifications should follow practices that leave a little choice to the designer.

W. G. WALL[6]:—There is a great advantage in having a coupling standard so that, when one manufacturer has furnished one half, the other half will match; but the ends of these couplings seem to be somewhat small and possibly they should be enlarged.

MR. UNDERWOOD:—If the outside diameter of the hub taper is omitted, would that meet the objections?

MR. NUTT:—Yes, if the term "material—steel" be left out also.

R. S. BURNETT[7]:—I think probably the Division specified steel as a precautionary measure because the proposed couplings probably are not proportioned to be sufficiently strong if made of cast iron or metals weaker than steel.

MR. NUTT:—If a designer does not call for a material of sufficient strength, he should not be designing such parts. When we include material in these recommendations, we no longer have a standard but a set specification. We want standards we can follow and have interchangeability without preventing progress. Someone might use a material better than steel but it would not necessarily be standard if "steel" is included in this report.

MR. BURNETT:—The points brought out may be true but the Division probably has in mind making the specifications reasonably safe so far as concerns the material that is commonly used in general marine practice today.

CHAIRMAN A. J. SCAIFE[8]:—Sometimes in drafting standards we may overlook important details and we should be sure that this specification is what we want before we approve it. If there is any serious question about this report we should refer it back to the Division and not try to clarify it here.

F. A. WHITTEN[9]:—It seems to me that this question should be worked out in connection with this particular subject, though a thing as important as the connection between these two parts should not go further into detail than to make them come together. I am in accord with the objections to the outside diameter of the hub taper provided there is not interference or some other constructional provision that makes it necessary to limit these dimensions.

PRESIDENT WALL: — Would substituting "material recommended—steel" meet the question?

CHAIRMAN SCAIFE: — Very good bronze forgings can be used these days, and in some cases the builders might want to use them instead of steel. Would you prefer to consider the recommendation with the material and the hub-taper diameter omitted?

MR. NUTT:—There are quite a few layouts using couplings that extend inside of the ear-box and run on washers or some oil-sealing device. The proposed taper dimension of the coupling hubs limits the designer to some definite angle which may or may not work.

CHAIRMAN SCAIFE:—It has been moved and seconded that this report be approved in revised form by omitting the outside diameter at the small end of the taper of the coupling hubs and the specification of "material-steel."

[The report was approved as revised.]

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[5] M.S.A.E.—Chief engineer, Guide Motor Lamp Co., Cleveland.

[6] M.S.A.E.—Consulting engineer, Indianapolis.

[7] M.S.A.E.—Manager, Standards Department, Society of Automotive Engineers, New York City.

[8] M.S.A.E.—Chief field service engineer, White Motor Co., Cleveland.

[9] M.S.A.E.—McCord Radiator & Mfg. Co., Detroit.

MARINE PROPELLER-HUBS

(Proposed S.A.E. Standard, p. 81)

ENGINE-BED TIMBERS

(Proposed Cancellation of S.A.E. Recommended Practice)

THE DISCUSSION

MR. UNDERWOOD:—A specification for Engine-Bed Timbers printed on p. 42 of the 1928 edition of the S.A.E. HANDBOOK seems, after investigation, not to be used and, in the opinion of the Division, is therefore of little value. The Division has endeavored to get the motorboat builders to use the specification but with so little success that it is now recommended that it be cancelled.

Motor-Truck Division

TRAILER HITCHES

(Proposed Cancellation of S.A.E. Recommended Practice, p. 81)

MOTOR-TRUCK BODIES

MOTOR-TRUCK CABS

(Proposed Cancellation of S.A.E. Recommended Practice, p. 82)

MOTOR-TRUCK DUMP BODIES

(Proposed S.A.E. Recommended Practice, p. 82)

Passenger-Car Division

LEAF SPRINGS

(Proposed Revision for S.A.E. Recommended Practice, p. 82)

Production Division

PLAIN CYLINDRICAL RING-GAGES

(Proposed S.A.E. Recommended Practice, p. 84)

THE DISCUSSION

W. J. OUTCALT[10]:—I think some mention should be made of the material of the bushings for the small-size gages and for the rings.

MR. BURNETT:—These materials were included in the original report but the Division felt it would be better to omit them. As a correction of the report, the length of the bushing in the small-size gages should be shown dotted beyond the face of the gage, as the bushing length will be flush with the gage when it is assembled and finished. The length L is intended only for stock bushings before they are put into the ring.

Screw-Threads Division

ROUND UNSLOTTED-HEAD BOLTS

(Proposed S.A.E. Standard, p. 85)

Transmission Division

CONTROL AND GEARSHIFT POSITIONS

(Proposed Revision of S.A.E. Standard, p. 87)

FLYWHEEL AND CLUTCH HOUSINGS

(Proposed Addition to S.A.E. Standard, p. 87)

CLUTCH FACINGS

(Proposed Addition to S.A.E. Recommended Practice, p. 87)

Attendance at Standards Committee Meeting

Members of the Standards Committee and other members of the Society and its guests in attendance at the Standards Committee Meeting were as follows:

Standards Committee Members

C. C. Bohner	C. A. Michel
A. Boor	S. W. Mills
H. S. Broadbent	H. C. Mougey
R. S. Burnett	Arthur Nutt
R. E. Carlson	W. J. Outcalt
D. S. Cole	O. A. Parker
E. H. Ehrman	D. M. Pierson
R. N. Falge	A. J. Scaife
J. D. Harris	H. W. Sweet
P. E. Holt	A. J. Underwood
C. M. Larson	E. W. Upham
B. M. Leece	S. O. White
B. J. Lemon	F. A. Whitten
E. S. Marks	F. G. Whittington
G. L. McCain	Ernest Wooler

Society Members and Guests

P. Altman	R. N. Janeway
V. G. Apple	C. V. Johnson
E. W. Austin	W. M. Johnson
A. L. Beall	D. M. Judd
A. J. Blackwood	F. M. Kincaid
Garth Cate	H. W. Kizer
T. E. Coleman	W. E. Lees
F. H. Colvin	A. S. McArthur
C. M. Compher	F. C. Mock
I. S. Crissman	W. W. Nichols
Henry Dakin	W. W. Norton
K. J. DeJuhasz	A. W. Reader
R. H. Drinkwater	N. L. Reed
M. A. Dunnigan	T. B. Rendel
W. B. Earnshaw	F. J. Richardson
C. M. Eason	O. C. Rohde
E. T. Ellis	J. H. Rose
John Erskine	G. A. Round
J. T. Fitzsimmons	C. L. Russell
D. T. Fraser	H. F. Schippel
F. H. Gleason	N. G. Shidle
C. E. Godley	K. D. Smith
C. P. Grimes	J. P. Stewart
Charles Guernsey	E. S. Twining
P. M. Heldt	W. G. Wall
F. C. Horner	C. B. Whittelsey
H. M. Jacklin	R. E. Wilkin

[10] M.S.A.E.—Standards engineer, General Motors Corp., Detroit.

Automotive Research

Standard Engine for Fuel Tests

Engine Built for Subcommittee on Detonation as First Step in Testing Fuel Knock

DETONATION was the subject of an open meeting held at the General Motors Building in Detroit on Jan. 15 under the auspices of the Subcommittee on Methods of Measuring Detonation of the Cooperative Fuel Research Steering Committee.

T. A. Boyd, Chairman of the Subcommittee, explained that upon the small group of men who constitute the Subcommittee had been cast the burden of developing an apparatus and a method for making knock ratings that everyone can agree to and adopt, together with the job of standardizing on a reference fuel or a scale of fuels that will place knock-testing results on a common basis; as Mr. Boyd expressed it, to enable everyone who is doing knock testing to talk the same language, which under present conditions of diversified apparatus, methods and reference standards, is altogether out of the question. A brief history of the undertaking and an outline of the future program were given by Mr. Boyd as follows:

Boyd Outlines Undertaking

At the February, 1928, meeting of the Cooperative Fuel Research Steering Committee of the American Petroleum Institute, the National Automobile Chamber of Commerce, and the Society of Automotive Engineers, the suggestion was made that something should be done about getting together on methods of measuring detonation. The suggestion was at once approved by the Committee, and at that meeting Acting Chairman A. Ludlow Clayden was instructed to appoint a Subcommittee on Methods of Measuring Detonation, with instructions to proceed with the development of a method of rating fuels for knock that would be of universal application and usefulness.

This group has already held five meetings, and one remarkable fact about these meetings is that at every one of them there has been a perfect attendance. This is true in spite of the fact that successive gatherings have been held at such widely separated points as Waukesha, Wis., and the City of Washington, which constitutes an unusual instance of faithfulness to a trust.

At the meetings of this Subcommittee the problem of rating fuels for knock has been discussed in all its phases; and, as a result of these discussions, two significant things stand out. The first of these is that all members of the Subcommittee either were or came into agreement on many of the essential points. The second is that there are certain definite problems in connection with the measurement of knock that need further investigation.

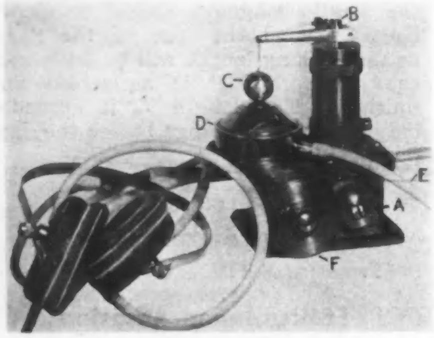


Fig. 1—Listening-Post Indicator

Shaft *A*, Driven from a Dynamometer at One-Half Engine-Speed, Carries Internally a Single Adjustable Cam Which, Through the Plunger, *B*, Raises the Ball, *C*, Once in Each Revolution of Shaft *A*. From the Highest Point in the Stroke of the Plunger, the Ball Is Permitted To Drop Freely on the Diaphragm Carried by the Sound-Box *D*, to Which One Branch, *E*, of the Stethoscope Tube Is Attached, the Other Branch Being Similarly Connected to an Identical Sound-Box, *G*, on Fig. 12. The Intensity of the Click of the Dropping Ball on the Diaphragm Is Controlled by the Micrometer Adjusting-Dial, *F*, by Which the Length of the Stroke of the Plunger *B* Is Controlled. Intensity of the Click Resulting from the Impact of the Ball Dropped from Varying Heights upon the Steel Diaphragm Can Be Matched Perfectly, by the Use of the Stethoscope, with the Clicks Due to Detonation Picked up by the "Audio" Diaphragm in the Listening Post of the Engine

Briefly, some of the things that members of the Subcommittee are in agreement on are that

(1) Measurements of knock should be made directly in an engine, and the cylinder dimensions of the engine used should approximate the average of those employed in practice.

(2) The engine should be cheap to build, should have minimum wear and long life, and should be simple enough to be fool-proof.

(3) The engine should have evaporative cooling. The main reason for this is that evaporative cooling assures a definite operating temperature, without complication or special means of control. Several laboratories already are using evaporative cooling, and without exception have found it to be beneficial.

(4) Knock tests should be made at low speeds, not greater than 1000 r.p.m. The main reasons for this are: engine quietness, avoidance of hot spark-plugs and exhaust-valves, minimum wear on the engine, and better performance of instruments used.

(5) Determinations should be made with the mixture ratio set for maximum knock.

Some of the questions that can be decided in an adequate way only on the basis of the results of further research are

(1) Just what type of induction system and fuel-metering device shall be used? These must depend to some extent upon the procedure adopted.

(2) What shall the instrumentation be?

(3) What shall the reference standard or scale be?

In laying the plans for their work, all the members of the Subcommittee were in agreement that the first thing to do was to design and build an engine to serve as the nucleus of the knock-testing outfit, so that whatever experimental work might be done on methods of rating fuels for knock could be done on a common basis. The group was in unanimous agreement also that, once all were on a common basis as regards apparatus, a program of tests should be undertaken to bring out the good points of every method now in use and to make it possible for all to agree upon methods of rating fuels for knock that will embody the maximum number of good points and the minimum number of bad points.

The Committee is able to report that distinct progress has already been made on this program. The first objective, that of designing and building a suitable engine to serve as the nucleus of a knock-testing outfit, has been accomplished. The effort has been to devise an engine that can serve as a basis of application of all the various representative types of method which might be used for knock testing.

The present plan is to make up a limited number of the engines first, for proving the suitability of the design by means of a series of tests participated in by all members of the Subcommittee. For two reasons it seems

best for the present to confine the use of these engines to the Subcommittee. The first is that the engine still has to be proved as to suitability before more than a limited number of them are built. The second is that the Co-operative Fuel Research Steering Committee, of which this group is a Subcommittee, has authorized the building of only 10 of these engines for the present. Hence the Subcommittee must arrange its activities so as to report results back to the main Committee for consideration and approval before definite steps are taken in any direction.

The Subcommittee proposes, first, to survey all the methods that have been or may be used in rating fuels for knock, to select typical ones covering the whole field of possible methods, and then to carry on a series of comparative tests to determine the suitability of each one of the representative methods and to find which ones work out to the best advantage. If, at the end of this series of tests, the engine shall have been found satisfactory for use in making determinations by a number of these representative methods, the Subcommittee can then report definite progress back to the Cooperative Fuel Research Steering Committee. It is natural to suppose that the parent group will throw the whole matter open to cooperative tests on a broad scale, as some such tests will need to be made before any final recommendations as to a standardized procedure or procedures can be made.

The designing and building of the engine have been supervised by H. L. Horning, assisted by A. W. Pope, and, although Mr. Horning is one of the busiest men in the automotive industry, he has generously contributed an unlimited amount of his time and his valuable knowledge of engines to the task of designing and building this engine.

Engine Shown and Described

The engine to which Mr. Boyd referred, and which is shown in Fig. 2, was on exhibition at the meeting and Mr. Pope was called upon to give a description of its details, which he did as follows:

This fuel-knock testing engine is the outcome of suggestions received from all members of the Subcommittee and others who have had experience in the knock testing of fuels. It differs from conventional design in many respects. The bore and stroke are 3¼ x 4½, respectively. Provision is made on the engine for the adoption of any of the equipment which has been found necessary in fuel-knock testing. This includes a built-in spark-position indicator; a tachometer driveshaft, for laboratories which do not have a dynamometer tachometer; an electric oil-heater and a three-heat switch to bring the oil up to equilibrium temperature quickly; an extension on the front of the crankshaft suitable for an indicator drive; an ignition-breaker drive free from excessive backlash; an opening into the combustion chamber suitable for indicator connections; a vapor cooling-system to maintain a uniform jacket temperature without attention from the operator; and, finally, a steam-jacketed manifold.

The crankcase is made with a flat self-supporting base so that no blocking or substructure is required to make an engine installation. The piston is usually long and heavy and is equipped with six ⅛-in. rings, all above the full-floating wristpin. The crankshaft and connecting-rod bearings are case-hardened. This is accomplished without difficulty by using a built-up crankshaft. The shaft is shrunk into the cheeks and the crankpin is clamped with bolts. The hardened shaft floats in bronze bushings, which in turn float in hardened bearings.

The connecting-rod big-end is not split, but is in one piece, hardened and internally ground, and carries a floating bronze bushing between it and the hardened crankpin. This floating-bushing type of bearing on the crankshaft and connecting-rod was selected because it was believed to have much longer life than plain bearings and that it probably will be quieter than roller or ball-type bearings.

Lubrication is by direct pressure to all rotating bearings and through a drilled connecting-rod to the wristpin. In addition to the pressure system, the engine is supplied with splash lubrication from a dip trough.

To have the engine suitable for all methods of knock testing, it was necessary to have a variable-compression cylinder. The engine has been arranged so that either a fixed-compression L-head cylinder or an overhead-valve variable-compression cylinder can be installed without disturbing in any way the crankcase assembly below the cylinder parting line.

Suggestions and Criticisms Sought

Comments, suggestions and criticisms on both the engine and the proposed program were solicited from those in attendance at the meeting, and Chairman Boyd also urged that anyone who has employed a method of measuring knock which differs from the more common and well-known methods submit a description to be included for consideration in the comparative tests.

During the informal discussion that followed, representatives of a number of laboratories described their methods of knock testing and frankly told of the limitations and difficulties encountered. A difference of opinion developed in a discussion of the relative merits of road tests and laboratory tests, the results of which, it was pointed out, were often not in agreement.

All agreed, however, that there is a crying need for a standard for rating fuels which may be written into Government specifications. This need has been increasingly felt with the development and wider use of aircraft owing to the fact that aircraft engines will not run satisfactorily on the ordinary domestic gasoline which contains no dope.

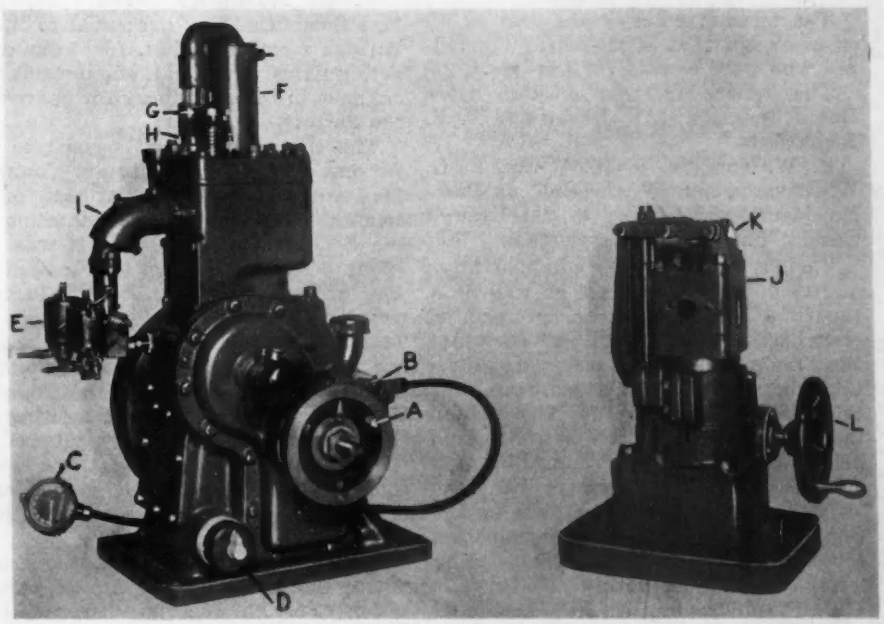


Fig. 2—Experimental Knock-Testing Engine

A, Spark-Position Indicator; *B*, S.A.E. Tachometer Drive; *C*, Tachometer Head; *D*, Three-Heat Switch; *E*, Two-Fuel Double-Float-Bowl, Single-Jet Carbureter; *F*, Vapor Cooling-System; *G*, Diaphragm-Carrying Sound-Box of Listening Post; *H*, Listening Post; *I*, Steam-Jacketed Manifold; *J*, Variable-Compression Cylinder; *K*, Overhead Valves; *L*, Compression-Adjusting Mechanism

Constitutional Amendments Proposed

Offered at Business Session to Effect Reorganization Plan—Officers Elected—Annual Committee Reports Received—Nominating Committee Members-at-Large Elected

THE 1929 Annual Business Session, which had been adjourned to Detroit at the time of the Annual Dinner in New York City, was convened on the evening of Tuesday, Jan. 15, with President Wall in the chair.

Announcement was made of the result of the election of officers for the year. Eleven hundred and fifty valid votes were cast in the election, those named on the regular ticket as candidates for the offices falling vacant being elected practically unanimously as follows:

President
W. R. Strickland
First Vice-President
Edward P. Warner
Second Vice-Presidents
O. C. Berry, Motor-Car Engineering
William B. Stout, Aviation Engineering
V. W. Kliesrath, Marine Engineering
J. B. Fisher, Stationary Internal-Combustion Engineering
E. N. Sawyer, Tractor Engineering
Councilors
W. T. Fishleigh, J. A. Moyer, O. A. Parker
Treasurer
C. B. Whittelsey

The term of office is one year in all cases except that of the three Councilors who were elected for two years.

The tellers in this election were David Beecroft, C. L. Drake and F. E. Richardson.

E. W. Templin, J. W. White, F. G. Whittington and W. G. Wall, as Past-President, will serve on this year's Council under previous election.

Various reports of administrative and technical committees, as well as a report of the Treasurer, as printed elsewhere in this issue of THE JOURNAL, were submitted and accepted. Vice-Chairman Scaife, of the Standards Committee, reported on the action taken by that Committee at its session held on the morning of Jan. 15. This action, reported elsewhere in this issue of THE JOURNAL, and approved by the Council, was accepted for submission for final adoption by the Society by letter-ballot of the voting members.

F. E. Moskovics, A. J. Scaife, and O. C. Berry were elected members-at-large of the 1929 Nominating Committee of the Society, the various geographical Sections having theretofore named their representatives on the Committee.

A discussion was had of the proposed reorganization plan providing for officer representation on the Council of various professional activities in which groups of Society members are particularly interested. F. E. Moskovics, Chairman of the Reorganization Committee and of the Constitution Committee, introduced the subject and also proposed Constitutional amendments to put the Reorganization Committee plan into effect. Remarks on the subject by other members and officers are given hereinunder.

DISCUSSION OF REORGANIZATION PLAN

PRESIDENT WALL:—Gentlemen, we now have a very important proposition ahead of us. As you know, we have had what is called a Reorganization Committee which was appointed this summer and has done a great deal of work. I think the members of the Committee deserve a great deal of cr dit for the time and thought they have devoted to the subject. I would like to have the chairman, F. E. Moskovics, report for the Committee. He is also Chairman of the Constitution Committee of the Society.

F. E. MOSKOVICS:—Your Constitution Committee had presented to it, by various members, what, for want of a better name, I will call suggestions for changes in the machinery for operating the Society.

The things suggested seemed so divergent that the Constitution Committee requested the appointment of a committee of broader representation of the Society, to learn what it was all about. The Reorganization Committee was accordingly named. It held two meetings, as was reported at length in THE JOURNAL for October and December of last year. A rather sketchy picture was made of all the suggestions presented at the first meeting of the Committee. That was sent out to the Society. In response there were some 70 letters from members. Many of the suggested changes were rather bitterly opposed.

At the second meeting of the Committee there was a very full representation; only a few members of the large Committee were not present. Things were gone into in detail. The meeting lasted practically from luncheon time until 12 o'clock at night.

At that meeting every person present expressed his views, and a separate vote was taken on every one of the "articles." Those present were unanimously in favor of all of the propositions announced as representing the view of the Committee; except that there were two votes against the proposition that the heads of the activities should be Vice-Presidents of the Society and members of the Council; one vote against the proposition that the heads of the activities should be elected by the Society from nominations made by the activity nominating committees, at least two nominations for each office; and one vote against the proposition that the two surviving Past-Presidents who last held office should be members of the Council.

I will propose in writing Constitutional amendments which it is believed will effect the changes contemplated by the Reorganization Committee. However, I want one or two gentlemen who are present and whose views on this matter are rather definite to give their ideas on it.

PREIDENT WALL:—At any Annual or Semi-Annual meeting of the Society, any voting member may propose in writing an amendment to the Constitution. Such proposed amendment shall not be voted on at that meeting, but, if duly seconded by a voting member shall be open to discussion and to such modification as may be accepted. The proposed amendment is then mailed by the Secretary to each member of the Society entitled to vote, at least 60 days prior to the next Annual or Semi-Annual meeting. At that meeting the matter is presented for further discussion and final amendment, and a letter-ballot is then sent out for final vote on the amendment, provided 20 votes are cast in favor of such submission. That is the way proposed Constitutional amendments are handled.

CONSTITUTIONAL AMENDMENTS

MR. MOSKOVICS:—Mr. Clarkson will read the drafts of Constitutional amendment that have been prepared. The paragraphs marked *C* represent proposed Constitutional changes. The paragraphs marked *B* in the copies distributed among you represent changes in the By-Laws, which the Council will take care of, because under the Constitution it is empowered to amend the By-Laws.

As a voting member, I propose in writing the amendments to the Constitution, shown by the paragraphs

marked *C* in the copies distributed among you.

SECRETARY COKER F. CLARKSON:—The mimeographed sheets, of which you have copies, are intended to set forth amendments to the present Constitutional provisions, and additional provisions, to carry out the ideas of the plan proposed by the Reorganization Committee. The text is clean, so to speak. That is, it is not shown in detail, by parentheses and underscoring, what would be omitted from a given existing paragraph of the Constitution, or what would be added; the purpose being to avoid confusion.

Naturally, no paragraphs are given on these sheets except those that it is felt should be amended or added.

The Constitutional amendment proposed by Mr. Moskovics is that existing paragraphs and new paragraphs of the Constitution of the Society shall read as follows:

THE COUNCIL

C 29 The affairs of the Society shall be managed by a board of directors chosen from among its Members or Honorary Members, which shall be styled the "Council." The Council shall consist of the President; the Vice-Presidents representing, one each respectively, the Professional Activities of the Society recognized by the Council on a National basis and specified in the By-Laws; six Councilors; the Treasurer and the two surviving Past-Presidents who last held office. One-third of the number of voting members of the Council shall constitute a quorum for the transaction of business. The Secretary may take part in the deliberations of the Council, but shall not have a vote therein. The Chairmen of the Administrative and of the Technical Committees may attend the meetings of the Council and take part in the discussion of questions affecting their Committees, but shall not have a vote.

C 30 Should a vacancy occur in the Council or in any elective office except the Presidency, through death, resignation or other cause, the Council may select a Member or Honorary Member of the Society to fill the vacancy until the next annual election. Should a vacancy occur in the Presidency, the Council shall select one of its number to fill the vacancy until the next annual election.

OFFICERS

C 35 Each year there shall be elected from among the Members and Honorary Members:

A President, to hold office for one year.

As many Vice-Presidents, each to hold office for one year, as there are recognized Professional Activities of the Society, specified in the By-Laws.

Three Councilors, each to hold office for two years.

A Treasurer, to hold office for one year.

ADMINISTRATIVE COMMITTEES

C 45 The President shall, within thirty days after taking office, appoint from the individual membership of the Society members of the following Annual Administrative Committees, designating the chairmen and the vice-chairmen thereof, as indicated below:

Finance Committee (consisting of five members); five members to be appointed by the President, he designating one of these five members as chairman.

Publication Committee (consisting of five members); five members to be appointed by the President, he designating one of these five members as chairman.

House Committee (consisting of five members); five members to be appointed by the President, he designating one of these five members as chairman.

Membership Committee; five members to be appointed by the President; the chairmen of the Membership Committees of the geographical Sections and of the Professional Activities, and a representative of the Society staff to be designated by the General Manager of the Society, to be members of the Committee. The committee members so appointed and designated shall serve for one year, during the administrative year. From these members the President shall name the chairman and the vice-chairman of the committee for the year.

Meetings Committee; five members to be appointed by the President; the chairmen of the Meetings Committees of the Professional Activities and of the geographical Sections, and a representative of the Society staff to be designated by the General Manager of the Society, to be members of the Committee. The committee members so appointed and designated shall serve for one year, during the administrative year. From these members the President shall name the chairman and the vice-chairman of the committee for the year.

Sections Committee; three members to be appointed by the President; the other members of the Committee consisting of one member of the Society to be elected from and by each geographical Section of the Society each year prior to the Annual Meeting of the Society. The committee members so appointed and designated shall serve for one year, during the administrative year. From these members the President shall name the chairman and the vice-chairman of the committee for the year.

Constitution Committee (consisting of three members); one member to be appointed by the President each year for a term of three years, the member of the Committee who shall have but one year yet to serve being the Chairman of the Committee.

NOMINATING COMMITTEE

C 46 The Annual Nominating Committee of the Society shall consist of one Member of the Society to be elected from and by each geographical Section of the Society prior to the Annual Meeting; and three Members of the Society who shall be elected at the Business Session of the Annual Meeting preceding the Annual Meeting at which officers are to be elected; no two of said three Members shall reside in the same Section district. The work and procedure of the Committee shall be as defined in the By-Laws.

PROFESSIONAL ACTIVITIES COMMITTEES

C 47A A Special professional activity may, in the discretion of the Council, be recognized by authorizing the establishing of a committee to represent the members of the Society interested in the activity, for purposes which are in harmony with the object of the Society. Such an activity so recognized shall be known as a Professional Activity; and when so recognized shall be listed in the By-Laws. It shall have such powers and act under such rules and regulations as the Council may from time to time prescribe.

Each Professional Activity so recognized shall be represented on the Council of the Society by a duly elected Vice-President, who shall be Chairman of the Committee of the Professional Activity he represents.

TECHNICAL COMMITTEES

C 48 The Council shall appoint annually such Standards, Research or other technical committees, or subcommittees or divisions thereof, as it may deem desirable, to investigate, consider and report upon subjects of interest to the Society. The Chairmen of such committees, and of their subdivisions, shall be designated by the President. Reports of such committees may be accepted by the Society and printed in its publications, and may be approved or adopted as the action of the Society.

GEOGRAPHICAL SECTIONS OF THE SOCIETY

C 51 The Council may, in its discretion, authorize the organizing of geographical Sections of any or all grades of membership, for purposes which are in harmony with the object of the Society. Such Sections shall have such powers and act under such rules and regulations as the Council may from time to time prescribe. The Constitution and By-Laws of such Sections shall be in harmony with the Constitution, By-Laws and Rules of the Society and shall receive the approval of the Council before going into effect.

PROPOSED BY-LAW CHANGES

As Mr. Moskovics said, necessary changes in and additions to the By-Laws of the Society would be made by the Council. The drafts that have been made in this connection for the consideration of the Council in due course, if the proposed plan is to be carried out, read as follows:

ELECTION OF OFFICERS

B 9 The Secretary shall mail on or before Nov. 1, to each member entitled to vote, the names of the candidates for office proposed for election by the Annual Nominating Committee or Committees and by the Professional Activities Nominating Committees.

B 10 The names of the candidates proposed by all official Nominating Committees and the respective offices for which they are candidates shall be printed in separate lists on the same ballot, each list of candidates to be printed under the names of the members of the particular committee which proposed it.

B 11A The Tellers shall not receive any ballot after the stated time of closure of voting, which shall not be later than Dec. 15. A ballot without the endorsement of the voter written in ink on the outer envelope is defective and shall be rejected by the Tellers. On Dec. 15 or within seven days thereafter the Tellers shall first open and destroy the outer envelopes and then canvass the ballots and forthwith inform the Council and the candidates of the result, the certified result to be submitted at the next meeting of the Society.

MEETINGS COMMITTEE

B 19 It shall be the duty of the Meetings Committee to pass on all matters of policy pertaining to the meetings of the Society, depending on the Professional Activities Committees to formulate the technical programs of National Professional-Activities meetings and special professional-activity sessions of Annual or Semi-Annual meetings.

The Meetings Committee shall arrange the general program, and, except as provided above, formulate the technical programs of the Annual and the Semi-Annual meetings and have general charge of the entertainment to be provided for these meetings. It shall prohibit the distribution or the exhibition for other than reference purposes of all advertising circulars or trade literature at the headquarters or at the meeting place of the Society.

CONSTITUTION COMMITTEE

B 22A It shall be the duty of the Constitution Committee to consider and report on all matters referred to it by the Council, and regularly proposed amendments to the Constitution.

NOMINATING COMMITTEES

B 24 It shall be the duty of the Annual Nominating Committee to organize at the Annual Meeting of the Society and to send to the Secretary, on or before Sept. 1, the names of consenting nominees for the elective offices next falling vacant under the Constitution; except the vice-presidencies. The report of the Committee shall be printed in the next current publication of the Society.

B 24A Each Vice-President shall be nominated by a Nominating Committee, consisting of four members, elected at a stated Business Session of the Professional Activity which he is to represent, held prior to Aug. 1. It shall be the duty of such committee to send to the Secretary on or before Sept. 1 the names of at least two consenting nominees for the vice-presidency representing the Activity. The report of each committee shall be printed in the next current publication of the Society.

B 25 A special Nominating Committee, if organized, shall, on or before Oct. 15, present to the Secretary the names of the candidates nominated by it for the elective offices (except the vice-presidencies) next falling vacant under the Constitution, together with the written consent of each. The report of the Committee shall be printed in the next current publication of the Society.

B 27 The President shall appoint three Tellers of Election of Officers, whose duties shall be to canvass the votes cast for election of officers.

PROFESSIONAL ACTIVITIES

B 36 An activity shall not be recognized by the Council as a Professional Activity of the Society until the sentiment of the members with respect to the need for, and their willingness to support, the proposed activity, as determined by a mail vote, assures the Council that the activity can be conducted successfully on a National basis. The names of the Professional Activities so recognized shall be listed in the By-Laws.

B 37 The following Professional Activities are recognized by the Council as of (date): ——————, ——————, ——————. [Names to be inserted.]

PROFESSIONAL ACTIVITIES COMMITTEES

B 39 The function of a Professional-Activity Committee is to represent and act for the members of the Society interested in the activity, conferring as necessary with the Council, and with the Administrative and the Technical Committees with regard to the work of the latter committees pertaining to the activity concerned.

B 40 Each Professional-Activity Committee shall consist of not less than twelve voting members of the Society, including as Chairman the Vice-President representing the Activity. Except as provided below, the members of each Professional-Activity Committee, including the Vice-Chairman, shall be appointed by the respective Vice-President, with the approval of the Council. The then chairmen of the corresponding Professional groups of the geographical Sections shall be automatically members of the committee.

B 41 An Activity Meetings - Committee shall be appointed by the Chairman of each Professional-Activity Committee. It shall be the duty of this committee to procure professional papers for, and to arrange the technical programs of, National meetings of the Activity; or special professional-activity sessions at Annual or Semi-Annual meetings, under the direction of the Meetings Committee of the Society.

B 42 An Activity Membership-Committee shall be appointed by the Chairman of each Professional-Activity Committee. It shall be the duty of this committee to carry on membership-increase work in the field represented.

B 43 Such other committees may be appointed by the Chairman as may be deemed desirable, and as approved by the Council.

B 44 Each Professional-Activity Committee shall hold at least one business session of the Professional Activity represented in each year, the time and place to be designated by the Committee with the approval of the Council, or by the Council.

MR. MOSKOVICS:—As a member, I have proposed the Constitutional amendments that have been read, for the purpose of bringing the subject up here and securing action on it. The proposed amendments reflect the views, I believe, of the Reorganization Committee. The proposed amendments have the approval of the Constitution Committee.

PRESIDENT WALL:—You have heard the amendments proposed by Mr. Moskovics. Is there a second?

W. R. STRICKLAND:—I second the proposal of the amendments to the Constitution.

PRESIDENT WALL:—We can now proceed with discussion of this subject.

WALTER T. FISHLEIGH:—As President Wall stated, the Committee has devoted a great deal of time and effort to the organization chart shown in the December JOURNAL, and, although at first glance the chart looks rather formidable, it really involves only two or three rather simple, yet extremely important, changes in the organization and functioning of our different divisions and their officers.

You can see on the chart a number of vertical green rectangles and also several horizontal red rectangles. You will also note the large red rectangle marked "Society Council." Those three diagrammatically represent the important advances which we think will be made by this reorganization.

Let us consider, first, the vertical green rectangles. They mean this: Instead of just talking about our interest in various activities, as we have in the last three or four years, saying, "Sure, we are interested in aeronautics; we are interested in aeronautical activities; sure, we are interested in body engineering and production activities; let the aeronautical men and the body men and the production men come in; we may not have anything much for them, but let them come in," the Reorganization Committee proposes and the chart indicates that the Council and the Society in general would formally recognize an Aeronautic Activity. The Committee proposes that we recognize a Body Engineering Activity, a Production Activity, and so on. We are not only to recognize them, but the vertical green rectangles indicate an organization for each activity, so that the Vice-President in charge of an activity will have a definite working organization, with assistants, committees, and a supporting line-up so that he can put the activity across 100 per cent.

That outlines the first important step; namely, we propose to recognize these various activities formally which we formerly recognized only informally, and we propose to give the officer in charge an organization with definite committees and executive machinery so that he can develop our aeronautical or body or production phases 100 per cent.

The second step is indicated by the large red rectangle which is called the "Society Council." Notice particularly that the Society Council rectangle extends down below and includes the Vice-Presidents who are in charge of the different divisional activities. That has been planned intentionally. It indicates a very important step in the reorganization program. In simple words, it means that, if you ask me or someone else to assume the responsibility of taking charge of a certain activity, say Aeronautic, or Body Engineering, or Production, you automatically make me a member of the Council, which is the directing and governing body for the whole broad program of the Society.

We, on the Reorganization Committee, cannot subscribe to the idea of asking a man to assume the responsibility of the work of a whole divisional activity of the Society and at the same time keep him outside the Council. His being on the Council benefits him in that he has continuous first-hand knowledge of and part in the formation and direction of all policies and activities of the Society. It benefits the Council by affording it first-hand information and assistance from each and

every activity; it also assures direct and immediate translation of Council action into divisional activity.

That is the second step; namely, the Council is to include the men whom you charge with the responsibility of the success of your various divisional activities. The Council becomes, in fact, the board of directors, upon which you naturally place the Vice-Presidents in charge of your different divisional activities. But not only these men; the reorganization plan proposes that the Society balance up the Council with broad-gage experienced men, the six councilors-at-large, whom you see indicated on the chart within the Council rectangle. These councilors-at-large should be representative of the broadest interests of the Society. They can be chosen from any part of the Country from any activity to assure balance and breadth of view upon our board of directors, the Society Council. That is the third point.

The fourth important point is that the Vice-President in charge of any activity is to be nominated by the Nominating Committee of that activity and elected by the voting members at large, who, by virtue of interest or association, choose to take part in the work of that activity. This method of nominating and electing Vice-Presidents in charge of the various divisional activities will, self-evidently, assure the election of the very best men. First, because the man selected recognizes the choice is not perfunctory, but rather a call for leadership from the whole body of his associates in his own field; second, the Nominating Committee of each activity knows intimately the men in that activity and their qualifications; and, third, the Nominating Committee of any activity knows intimately the needs and the desires of that activity.

The fifth point is illustrated by the long, horizontal, red rectangles. These rectangles simply mean that we propose a direct tie-up in organization between each of the divisional activity committees and the corresponding National committee. For example, the National Meetings Committee contains five members-at-large, appointed by the President of the Society, but in addition thereto includes the chairman of each of the Meetings Committees of the various recognized activities, so that there is a direct tie-up between the Meetings Committees of the various activities and the National Society Meetings Committee. To put it the other way around, the National Meetings Committee, outside of five members-at-large, is made up of the Chairmen of the Meetings Committees of the various divisional activities. The advantage of such National committee organization is at once apparent, in that, for any and every National meeting, we shall have a broad-gage committee, representative of every activity and prepared to arrange meetings and sessions of interest and value to the specialists in every activity, Passenger Car, Body Engineering, Aeronautical, Production, and so on. The same organization and theory apply to the Membership Committee.

To sum up, the five important points are as follows:

(1) We formally recognize and organize several divisional activities.
(2) We include in the Council the Vice-Presidents in charge of the various activities.
(3) We provide on the Council six Councilors-at-large.
(4) The Vice-President of any activity is nominated by the Nominating Committee of that activity.
(5) The National Society Meetings Committee and Membership Committee include the chairmen of the corresponding committees of the various activities.

I have really been surprised at the somewhat heated arguments that have been brought up in connection with this attempt to improve our organization. There has been some argument in the Committee; there has been a lot outside of the Committee. Peculiar charges have been made against the scheme, largely by people who have misunderstood the idea. The words they have used have been too strong, and could only have been prompted by misunderstanding. The proposed improvements have been called "radical." They have been dignified by all sorts of names. As a matter of fact, the five steps outlined are the five simple steps by which we propose to change, and we think improve, the present status.

The one big point upon which we must not become confused is this: There is to be no more division of the membership than at present. Note particularly that there are no division lines through the green rectangle representing the "Society Membership." Every Society member may be interested and take part in one or two or half a dozen activities, depending merely upon his own interests and activities. Someone asked me today: "When you get all of this reorganization scheme going, what division are you going to belong to?" My answer was simply: "Not any, because there are no lines of division in the membership. In fact, I hope to be interested in every body activity, most aeronautical activities, every passenger-car activity, and in much in the way of production activity."

Nobody is going to ask you or me, as S.A.E. members, which division or which activity we belong to, because, under this reorganization plan, you and I belong to all of them, just as we do at present. This chart represents an executive divisional organization designed to give to the officers in charge of activities, National or divisional, that organization which seems best to enable them to put over all of these different activities 100 per cent for all of us. The Society, in general, should be, and we believe is, interested in all of them.

Henry M. Crane:—I am not going to say, at the start, whether I am opposed to making the change now, or not.

On the other hand, I couldn't have been a member of the Council, I couldn't have been Vice-President in charge of aviation activities, and I couldn't have been President of the Society and still listen without saying something in reply to what has been said about the various operations of the Society in the past, that is, the narrow-minded operations of the Council and the fact that none of the lesser activities ever had much of an opportunity.

I wouldn't be fair to Dave Beecroft if I didn't tell you fellows that, when a lot of the activities that are now causing a reorganization didn't amount to anything, he stood up in the Council meetings, meeting after meeting, and said "These people are engineers. How are we going to interest them in the Society, and how are they going to do something for us?" As a result of his foresight at that time, although he wasn't personally in any of the activities, most of them were organized because of him, such as production and a number of the others, including transportation.

I would not stand here for a minute and try to tell you that the proposed reorganization plan is going to make or break the Society. It is not. The Society is going to be as good as the men who are interested in its operation. It will never be any better. If this system better meets the feeling of the men who are most interested in the Society and in its activities and will make it easier for the best men to take the time required to operate the Society successfully, then I say, go to it; it probably is the best thing to do.

A great fallacy has existed in the past regarding some of the Society operations. Mr. Fishleigh repeated the fallacy just now. It has been stated, as at the Reorganization Committee meeting, that the Second Vice-Presidents have been somewhat ornamental and not working Vice-Presidents. A motion was passed to make them working Vice-Presidents.

All of you probably know of the Airplane Reliability Tour, which is an annual event. It is called the Ford Reliability Tour, as a rule. How many of you know that the tour was the conception of P. G. Zimmermann when he was Vice-President in charge of Aeronautics? That he did all of the work of organizing it, getting people interested in it and getting it started? That was done under the old organization: there was nothing whatever to prevent his doing that job. He came to me with the idea. I made one or two suggestions to make sure of certain kinds of support

He went right out after that support. The tour has been a National event ever since.

Many things have been said against the past organization. One of the things stated is that the men who have been elected to the Second Vice-Presidencies have failed to operate. Unfortunately, there were a lot of small activities in the Society in which not many men were interested but had to be represented on the Council. I can tell you that in the past those activities have been represented by the ablest men on the Council, as a rule by those who were primarily interested in something else, but who, in the Council, were primarily interested in the advancement of the Society as a whole.

For that reason, they have wished to build up the Society. They know that it has always been the talk at the Council meetings that the only way the Society can be filled up is by doing something for the men you want to interest. You want to give each group something along their line of work.

My own feeling is that it isn't a good way to encourage the body builders by setting them off by themselves and letting them talk to other body-building men only. I have always felt, and I feel today, that one of the worst things we have to contend with in the industry is the lack of teamwork between the body and the chassis builders.

I have felt strongly that, if we could have chassis engineers attend the body sessions, and body engineers attend the chassis sessions, we could do more good than by segregation. I have kicked to the Meetings Committee because it has scheduled simultaneous body and engine or chassis sessions during Annual Meetings. By acting this way I believe that we have definitely increased the cleavage between the two branches. I think what we want in the Society, if we can get it, is more engineers interested in many different lines.

It is very interesting to me to go over the list of Past-Presidents. I did that awhile ago. I have seen the variety of activities they were interested in. I think the one reason they became officers of the Society was their broad interests.

Riker, Fay, Hess, Coffin, Souther, Donaldson, Alden, then Marmon—you will remember that Marmon was prominent in aviation during the war—Leland, VanDervoort, Huff, Dunham, Kettering. We know there isn't a thing in the world that Kettering isn't interested in. Manly's work was in aviation, transportation, trucks, buses, and all sorts of things. Vincent was qualified for four different types of Vice-Presidency. Beecroft, with the broadest possible interests, Bachman, Alden, and the rest of them.

I was Vice-President of Aviation Engineering before I was President. The first big splash I ever made was in the motor-boat line. I am in the motor-car line now. Then came Horning, who builds engines for all sorts of things; before you know it he may take up airplane-engine building. Then there were Lítle and J. H. Hunt.

Possibly, the proposed type of organization isn't going to decrease the interest of the men of broad interests in the organization. If it doesn't, a little more definite line-up of responsibilities may be worthwhile.

One proposed change in the By-Laws brings out very clearly one point I have made. That is the proposed B-36, to read as follows: "An activity shall not be recognized by the Council as a Professional Activity of the Society until the sentiment of the members with respect to the need for, and their willingness to support, the proposed activity, as determined by a mail vote, assures the Council that the activity can be conducted successfully on a National basis. The names of the Professional Activities so recognized shall be listed in the By-Laws."

There is our dear, old referendum again. We did not do it that way in the past, for it was not a good way to do, and it won't be today. The Council will always have an opportunity to establish an activity and it should certainly do so often before there is a very widespread demand among the members for such an activity.

The proposed reorganization plan will make it less probable that the members interested in other lines will ever recognize the desirability of some activities that haven't already been organized by the Council.

Close scrutiny of the proposed plan indicates what I say. We start off with the Vice-Presidents in charge of the Passenger-Car Activities, Aeronautical Activities, and Production Activities. There is a decided break there. What production activities are we discussing? Passenger-car or aeronautical? There is a lot of difference of opinion among the aeronautical crowd as to whether aeronautical and passenger-car production should be included in the same activity.

Let me say that whether or not we are going to be able to hold the aeronautical crowd in the Society, with all the advantage we have to hold them, is going to depend a lot on whether we can maintain their interest and supply their needs. They are not going to be willing to accept only a Vice-Presidency on Aviation Activity and be joined in transportation engineering and production, with trucks and motorcoaches. We do not mention aerodynamics, which is an entirely different question and does not appear in the other lines at all—that is not worthy of special consideration and separate consideration even though we have, in some of the other things, separate consideration, as in the case of motor-trucks and motorcoaches, and in the industrial engine and tractor activities.

I feel that the present proposed plan is a lot better than the original proposal to name definitely these Vice-Presidents in the Constitution. Still, it has to be viewed from the standpoint of what it will look like five or ten years from now, if we really do what we ought to do for these other activities. If you do that, you cannot possibly evade adding four or five more Vice-Presidencies, and possibly even more than that, to this layout.

Whether or not that is a good thing to do, I am very far from clear. Whether you can get good men to take those jobs, I do not know. If you cannot, you will never make up in multiplicity of men what you lack in quality.

I do not want to say anything bitter about this proposition, but I do think that anyone who calls it radical is far too complimentary. It doesn't appear to me to be radical in the least. It is distinctly reactionary, I think. It goes back to the town-meeting method of operation. In a small, compact organization in one place, the town meeting wasn't a bad thing. Everybody could get together and talk things over. They got along fine. But in a country the size of this, with the number of activities we have, I question whether the town-meeting system is the best system.

From Mr. Fishleigh's description of the plan, I gather that somehow or other these good men who might have had these jobs in the past didn't get a hearing. I have known a lot of the work of the Nominating Committee and I have seen the result of their work. If they didn't ferret out the good men and get them into the Council of the Society, it wasn't because they didn't try. The only reason they were not able to do it was that the men wouldn't accept the jobs. Possibly, they will take the jobs when they are handed to them in the proposed way quicker than they did take them in the old disguise as a member of the Council or as a Vice-President in charge of one of the original activities. The present Second Vice-Presidencies are, as you know, predominantly historic. They resulted from the amalgamation with the Society of a number of other societies over ten years ago. Each one had its own recognition.

The very result of that shows how wrong you can be in this sort of thing. One activity stays and the others die out. Some societies come on, and other activities fade out.

I would like to point to the Vice-Presidency in charge of Industrial Engine engineering and Tractor engineering. The suggestion for change was first brought up three or four years ago on the basis that the Stationary-Engine engineering Vice-Presidency was no longer justified. The old stationary engine was rather defunct; there wasn't anything going on in that line.

I can go back to the time when I saw

an Otto-cycle engine, with open-flame ignition, running. It was around that engine that the old stationary-engine society was formed. Later on I operated a shop of my own with a single-cylinder White & Middleton engine. There were a lot of other makes. With the advent of gasoline they faded away, until most of the companies passed out.

When the proposal to abolish the Second Vice-Presidency for Stationary-Engine engineering came up, I started thinking about it and began looking around. I suddenly realized that we were asleep at the switch. There were actually in operation more engines, using more stationary horsepower of the kind that we are really interested in, similar to our automobile engines, than there had ever been in the past.

You cannot pass any building operation, or any repair work on railroad tracks, or anything of the kind, without hearing the chug, chug, chug of one of our gasoline engines. Yet we were proposing to throw the whole thing out of the window.

I figure that a little too much of this kind of specialization is apt to land us in just that sort of thing.

I repeat, I do not say today that I would vote against the present proposal. If it represents the considered desire of the Society—and I believe Chairman Moskovics said it represents the considered opinion of the Committee—then I say that the thing to do is to go ahead and try it. We can always change it again if it doesn't work.

The main thing is to see whether it interests the able men in the work of the Society and makes the work so simple that the men who we know should be doing work for the Society, and aren't today, can be induced to do that work. You all know, and I know, many men of Presidential timber among the engineers, but we cannot get them even to take a Society office. I would like to drag them in here if I could.

I do not think this system is going to help to do it. If it does, however, I am certainly for it, and I will do all I possibly can to push it along.

During the Summer Meeting this same question came up as to aeronautic activities. I heard a good deal of criticism to the effect that nothing had ever been done for aeronautics by the Society. This astonished me because practically half of the Presidents of the Society in the last ten years have been interested in aeronautics. I know that there were a great many aeronautic meetings, and a great deal of interest in the subject.

I feel that changing the organization of the Society as proposed does away with nearly half our ammunition available for use in a discussion as to what organizations should maintain aeronautical activity in an engineering way in this Country. We, as a Society, are interested, all of our engineers are interested, in all of the various activities in the aeronautic field. There is hardly a single feature of design or construction used in the airplane that did not begin in the motor-car, or vice versa; or in the motorboat, and so on. Our argument is based on the fact that automotive engineering is the designing, constructing or maintaining of a type of vehicle, including the airplane, that has such a simple powerplant that the operation can be controlled by one person, and that person may be one of no engineering intelligence. We are the proper people to do any job in this line of engineering, but you cannot divide it up into all of these activities and do it full justice, in my opinion.

This proposed organization represents a method of operation and is used simply as a method of operation. It may be the best machinery we have available to do the job at the time. It may make these fellows feel better to be Vice-Presidents in charge of something than it would be to be members of the Council. If it does, then more power to them. I have no objection at all, although if you will go around looking for men to take these jobs you will certainly find some pretty active competition among two or three of the activities as to who is going to get the men. Every man who is worth putting on any one of those jobs is usually capable of taking two or three or four of those jobs equally well.

President Wall:—Mr. Crane has given you the other side of the picture. There is a great deal in what he says. As to a considerable part of it I do not agree with him. In fact, the plan was got up to safeguard some of the things he speaks of. It wasn't grabbed out of the air. We have had agitation for this for several years and it was only after a great deal of pressure had been brought to bear that we finally appointed a committee to go into the subject.

Mr. Moskovics:—In the Reorganization Committee I was a representative of Mr. Crane's views on a good many of the points he mentioned.

I think I have served on as many Nominating Committees as has any man in the Society. I have tried to pick, conscientiously, good Vice-Presidents. I think I have picked as many lemons as anyone. I say that from the standpoint of knowing as many men of the Society as any one.

Somebody from the Detroit Section said that their experience was the same; if a man was chosen for office you could tell him to do something and he might do it; but, when that same man was chosen by his crowd, or his group, he not only accepted the job but he did the job in better form. They told me that and I said I would bow to their experience because mine hadn't been very good and they had had good experience. Their point was that the fellow will feel it a distinct obligation not only to head the activity but to work on that activity if his crowd chooses him.

My opinion had been different, but somehow I changed my view on certain of those things. I was an exponent of this proposition in the Committee: If a man was any good he wouldn't have to have a title; he would serve without it. Then it developed that if that fellow was going to function intelligently as the head of an activity, if he had at his finger tips the full knowledge of the whole activity of the Society, he could do the job more intelligently and to better effect if he did have the title.

These things didn't mean much except as a handy way of bringing more coordination.

I objected as much as anyone could, to what we, at one time, called stratification of membership. But I want to emphasize—and I am anxious to do this, Mr. Crane, because I accede to no one in my admiration for the work you have done for the Society, work that had nothing to be gained but the return of a good job well done—I want to call attention to the fact that the proposed activities are not segregations along the lines of the Divisions of the American Society of Mechanical Engineers. They are mental segregations. They are directions of mental activity. The body of the Society remains just as unbroken as it could ever be.

The point of what a given production fellow is going to produce was taken up also in the Committee, as well as the criticism that there will be more Vice-Presidents. As somebody so well put it, there may be 20. Suppose there are; if there is constructive room for them, it is all right.

We didn't see any danger in that. I am reviewing here some of the things that came up in Committee and the answers to them. I made no notes because I simply want to bring up one or two things.

The Industrial Engine and Tractor activity was commented on at the time. It was felt that, by having a fellow in charge of that, one chosen by the activity itself and knowing every phase of it, including, for instance, activity along Diesel-engine lines, and this and that line, a good deal could be accomplished.

In the past a good many of the Second Vice-Presidents have simply accepted the positions as sort of an idle honor. They have figured that was all they had to do, and that was all. The Reorganization Committee felt that if these men came from the groups that are interested in the respective activities, they would feel personal responsibility to serve actively.

I am stating the things on which I disagreed with the Committee. I agree with everything that is included in the proposed plan now. I wouldn't have given the report of the Committee if I didn't agree with it. I do not want to stand on two sides of the fence. I mere-

ly want to bring out how we arrived at our conclusion.

It seems to me that, under the circumstances, the proposed plan should make a very good working arrangement. I admit that it may be experimental; but so is any other thing.

As Mr. Crane so well put it, all finally depends—we all admit that—on the character of the men elected to hold office. We assume of course that this will be good.

H. A. HUEBOTTER:—Mr. Crane's remarks are, as usual, backed by sound judgment. Permit me to take this opportunity, however, to make some suggestions that I have talked about and thought about for the last year and a half.

My contact with the heavy-oil-engine industry has given me a perspective of the Society of Automotive Engineers as it looks from the outside. Diesel engineers, as a whole, show an entire lack of interest in the S.A.E. Our standards, which are naturally based upon automotive requirements, are unfitted to oil-engine design. From the standpoint of engine design, the bond of sympathy between the Diesel engineers and the Society of Automotive Engineers is highly tenuous.

But the quality of the S.A.E. which seems to evoke the admiration of the Diesel men is our cooperative spirit, and the freedom with which we discuss openly the problems we have encountered and solved. The Diesel industry is fiercely competitive, and most of the manufacturers guard carefully their individual design and production methods.

The manufacture of oil engines is, however, increasing rapidly, and the practices adopted by the automotive industry in mass production are gradually extending to the large-engine field. It is on this basis that the automotive and the Diesel industries can meet with mutual benefit. Later, both groups of engineers will discover that they have similar problems in design, but have overcome them in different ways.

The connection between this analysis and the proposed reorganization plan is briefly this: The plan offers a means whereby the S.A.E. can receive the Diesel engineers into its general membership and at the same time offer them a place in which they can consider their own particular problems. An activity in the S.A.E. dedicated to the interests of oil engines, natural-gas engines, and large gasoline and distillate-engines will appeal to engineers who wish to enroll in a stable, well-organized association, but who refuse to be dominated by the overwhelming majority of automotive members of which the Society is composed.

To that end, then, I propose the following change in the distribution of major activities as the chart issued with the December issue of THE JOURNAL shows them. Instead of the two divisions of motor-vehicles and that of tractor and industrial engines, I suggest the following three divisions:

(1) Passenger Vehicles
(2) Commercial Vehicles
(3) Industrial Engines

Division (1) would include the light, active, "pleasure" type of automobile, with its parts and accessories, which constitutes the major part of the automotive industry.

In Division (2) would be assembled the heavy types of motor-vehicle, including buses, trucks, tractors, railway passenger-cars, railway section motorcars, and locomotives driven by internal-combustion engines. The characteristics of powerplants and heavy-duty drives are closely allied in all of these vehicles.

Division (3) would give the Diesel-engine designers and manufacturers a chance to join the Society of Automotive Engineers with the assurance of exercising complete control over their own sessions. Such meetings would improve the condition of the oil-engine industry by enabling the engineers to meet on a cooperative rather than a competitive ground. It would broaden both their interests and our interests, and would constitute a big forward step in establishing the S.A.E. as an organization of extensive and harmonious activities.

G. WALKER GILMER, JR.:—Any group that brings in more working members to increase interest in its activity in the Society is bound to advance. Recognition of each new activity will afford opportunity for more work by more men in the Society. For that reason I favor the proposed plan. I agree with what Mr. Huebotter said. With the aeronautic men making their activity more and more prominent in the Society, greater and greater results will be accomplished.

A. J. SCAIFE:—Inasmuch as I was a member of the Constitution Committee at the time this subject first came up, and afterwards was Chairman of the Committee, I want to say that the matter was really precipitated by the fact that some of the members felt they were not represented on the Council. J. F. Winchester was very active in the Operation and Maintenance Division and argued that it should have a Vice-Presidency; also that there was one group that was not very active, that of the stationary engine. The thought was simply to abolish the Second Vice-Presidency for the latter and to establish one for operation and maintenance. Naturally, that gave rise to the thought, What about the body and the production men? And what about the other divisions?

The original idea was to have something that would be flexible, such as this plan brings out. Whether the present proposal is going to answer the purpose or not I do not know, but I, for one, am willing to see it tried, inasmuch as it gives all of the members of the Society an opportunity to express themselves through some activity.

[There being no other business to be taken up, the session adjourned.]

The Annual Meeting

(Continued from p. 122)

recommending to the Council that a special Student-Activities Committee be appointed to promote membership and activities of engineering students.

Other recommendations to the Council regarding student activities advise the payment of mileage to one student member, chosen by each Student Branch, to attend the Annual Meeting; the establishing of a first and a second prize for the best student paper submitted during a calendar year; the appropriating of $25 to each Student Branch each year to defray incidental expenses; and the collecting of Student-Branch dues by Society headquarters rather than by the Student-Branch officers. The discussion also covered the desirability of arranging to have the leading engineering schools of the Country addressed each year on automotive engineering subjects by prominent members of the Society.

Action on Sections Matters

The recent establishing of two new Sections, on a probationary basis, was reported. These are the Canadian Section, with headquarters in Toronto, and the Northwest Section, with headquarters in Seattle, Wash.

In the discussion regarding the possibility of forming new Sections, attention was given to the question of changing the requirements that must be met before a Section can be established; and it was the sense of the meeting that no change should be made in the requirements.

Reference was made to the recommendation of the Sections Committee to the Council last June that the necessary steps be taken to make the Sections and National dues one charge of $20 against each member in the United States, $5 of this to be made available to the nearest Section, if needed. This recommendation had been tabled by the Council. The Sections Committee, after a lively discussion, voted again in favor of the recommendation.

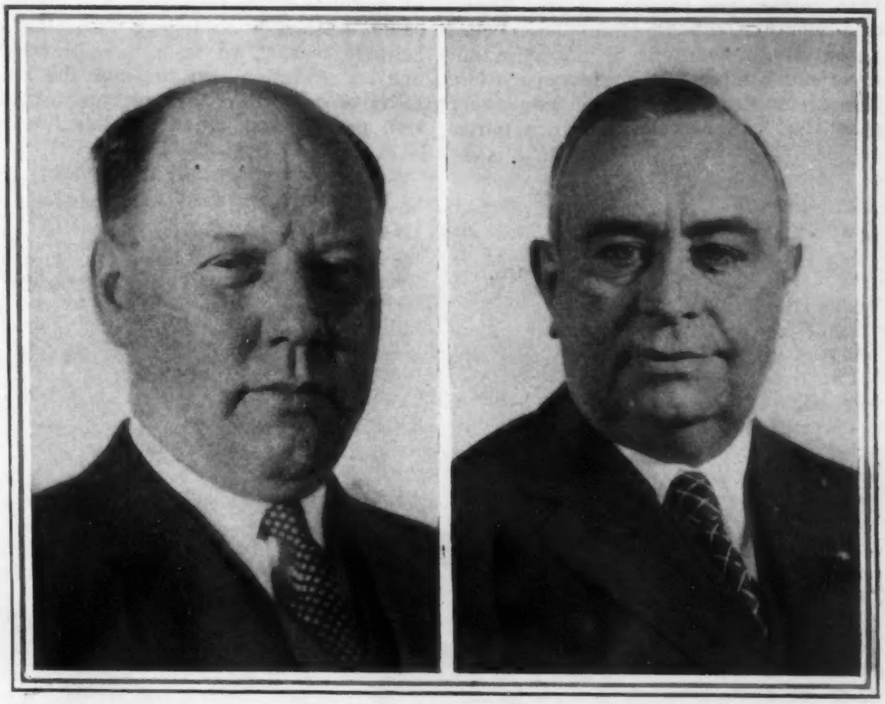
The recommendation of the Sections Committee to the Council last June that a reasonable entertainment expense for the Sections be recognized on the same basis as other legitimate expenses was discussed, as it had been referred by the Council back to Sections Committee for further consideration. The Committee reaffirmed its earlier recommendation and further recommended that, in recognizing this expense, the Society allow a net appropriation, if needed and desired, of $50 for paid attendance up to 150; $100, above 150 and up to 350; and $150 for more than 350 paid attendance at any one meeting.

Action taken by the Council on the several recommendations of the Meetings and Sections Committees is reported in the account of the Council meetings beginning on p. 246.

The desirability of cooperation between the Sections and the National Membership Committee was urged, and it was the sense of the meeting that the Sections should cooperate with the Membership Committee in every possible way.

An editorial by W. T. Fishleigh, preprinted from THE JOURNAL and sent to the Sections Committee members in advance of the meeting, was commented upon by those present. In the editorial, which appears on p. 124 of this issue, the author lists certain factors that he regards as fundamentals in staging engineering meetings if they are to be successful from the viewpoints of vigor, enthusiasm and inspiration as well as technical excellence. The Committee heartily endorsed Mr. Fishleigh's ideas.

The next meeting of the Sections Committee will be held during the Summer Meeting, unless previously called by the Chairman.



THE PRESIDING OFFICERS AT THE STANDARDS AND SECTIONS COMMITTEE MEETINGS

A. J. Scaife (Left), Who Presided at the Standards Committee Session; and Vincent G. Apple, Chairman of the Sections Committee

Fuels and Lubricants

Gum in Gasoline, Knock Testing, Oil Fluidity, and Grease for Chassis Parts Debated

FUELS and lubricating oils are without a doubt in the front rank of controversial subjects, as Chairman G. A. Round pointed out in the session devoted to these topics on the afternoon of the 16th, and as was borne out by the long discussion that followed the reading of the four papers, two of which dealt with gasoline and two with lubricants.

The paper by J. O. Eisinger and V. Voorhees of the Standard Oil Co. of Indiana, entitled, The Effect of Gum in Gasoline, attacks a most important present-day problem affecting engine operation. The trend toward high-compression engines which have a tendency to knock and therefore require cracked fuels, which are fairly high gum-forming fuels, makes the problem one of growing importance.

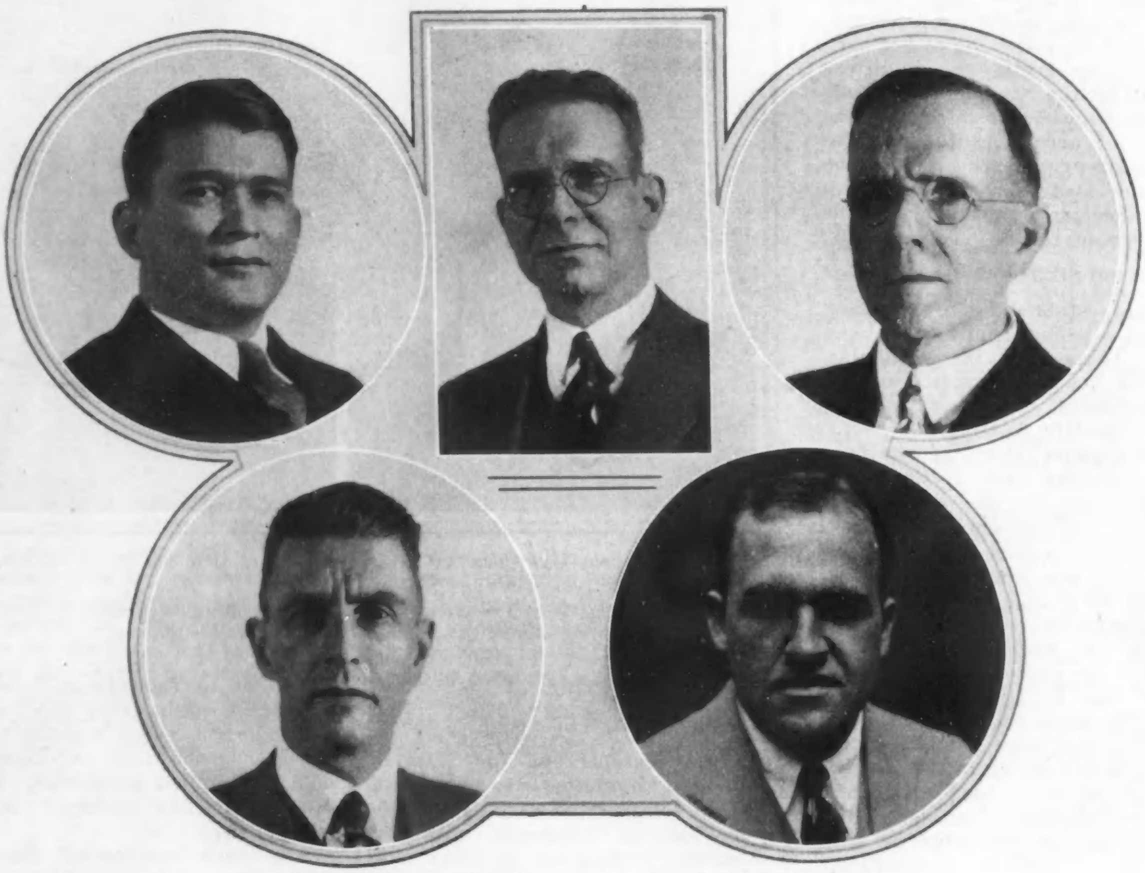
According to the results of tests made on a single-cylinder air-cooled Delco engine, it is the preformed gum that causes the trouble in the engine and whether the gasoline has a high potential gum-content or not does not have much effect on engine operation. The tests also indicate the amount of gum that can be tolerated in a motor fuel before the effect on operation will be noticeable.

Gum causes a deposit on the carbureter and in the intake manifold, and on and around the inlet valves in the combustion chamber, but does not affect the exhaust valve. Sticking of the exhaust valves probably is caused by certain conditions of the lubricating oil. Both the quantity and character of the gum formation were affected by the temperature of the manifold wall and the writers of the paper incline to the belief that the deposition of gum is greatest at high temperatures.

Tests for Gum in Fuel

The second part of the paper took up the causes and methods of testing gum formation in gasoline. It was shown that gum is chiefly a result of oxidation and, further, that once a gasoline has started to form gum, the formation usually continues as long as air or oxygen is present. A thorough study of methods of testing gum was undertaken with the object of obtaining a reliable test. Two tests were devised, one an oxidation test to show the stability of a gasoline toward gum formation particularly when the gasoline is stored, and the other a modified steam-evaporation test to show actual gum in solution at the time the test is made.

When Mr. Eisinger and Mr. Voorhees presented some of the results of their work at the American Petroleum Institute meeting last December, considerable interest was aroused by the conclusion that the content of gum which was formed in the engine was dependent only upon the content at the time the gasoline entered the fuel-induction system and did not bear any relation to the oxidation or polymerization. J. B. Hill, of the Atlantic Refining Co., reported that at the company's laboratory the results were considered somewhat startling, and consequently they had determined to try similar tests for themselves. They made a brief but carefully conducted series of comparisons of the modified steam-oven test, described by Mr. Eisinger, and their own chromium-plated-dish test. The results confirmed Mr. Eisinger's conclusions and showed that apparently the chromium-plated-dish test is not a test of the gum derived from oxidation, as was supposed. However, they are still somewhat surprised at the considerable quantities of gum that the investigators reported in their engine test work.



Speakers at the Fuels and Lubricants Session

F. R. Staley (Upper Left), of the Texas Pacific Coal & Oil Co., Who Discussed Fluidity of Lubricating Oils; G. A. Round (Upper Center—For Once, George Isn't "Round as in Circle"), of the Vacuum Oil Co., Who Presided; C. W. Spicer (Upper Right), Who Discussed Better Chassis Lubricants; J. P. Stewart (Lower Left), of the Vacuum Oil Co., Who Submitted Some Thoughts on Detonation Measurements; and J. O. Eisinger, of the Standard Oil Co. of Indiana, Who Discussed the Importance and Significance of Gum in Gasoline

J. R. Wright, of the Standard Oil Development Co., reported road tests being conducted to determine the safe limit on the actual predissolved-gum content of gasoline.

Debate on Knock Testing

Some Thoughts on Knock Testing, by J. P. Stewart, of the Vacuum Oil Co.,

brought out a difference of opinion on the effectiveness of road tests for rating knock value. Neil MacCoull, of the Texas Co., based his objection to road tests on the fact that numerous complications are introduced by the distribution systems in cars. The opportunity to try out laboratory results on the road serves to rationalize an operator's technique in the laboratory, was the thought expressed by D. P. Barnard, 4th, of the Standard Oil Co. of Indiana. J. R. Wright, of the Standard Oil Development Co., pointed out that oil refiners are interested in what the average user says about the knock value of a fuel, and he believed road tests are valuable as an indication of whether the laboratory values are such that they can be interpreted by the user.

A question arose regarding the advisability of testing fuels at the mixture ratio that gives the maximum knock. T. A. Boyd, of the General Motors Corp., justified this practice by pointing out that nearly every car, regardless of the adjustment of the carbureter, does give variations in mixture ratio under different conditions of operation, different throttle settings and different loads and speeds, and one of those combinations is bound to pass through the point of maximum knock. O. C. Berry, of the Borg-Warner Corp., voiced the sentiment of the carbureter man on this point, namely that one carbureter is declared to cause worse knocking than another when the difference is dependent on the mixture ratio. It was generally admitted that the mixture ratio that gives the worst knock is just on the economy side of the mixture that gives the maximum power, thus forcing the carbureter engineer to disregard economy and so design his carbureter as to supply a mixture that will drown out the knock.

Fluidity of Lubricating Oils

The consistency of aviation-engine oils below their pour-points and the significance of dewaxing paraffin-bearing oils were treated in the paper by E. R. Lederer and F. R. Staley, entitled Fluidity and Other Properties of Aviation-Engine Oils, which is printed in this issue, beginning on p. 149.

R. E. Wilkin, of the Standard Oil Co. of Indiana, in discussing the paper, stated that this examination of oils at low temperatures was made to determine the effect on the torque required to crank the engine and the effect of low temperature on oil circulation. He discussed and demonstrated by graphs the effect of pressure on viscosity. J. C. Geniesse contributed to the discussion the results of tests made by the Atlantic Refining Co. on oils at low pressures, which showed that one oil would be more viscous at 10 lb. per sq. in. and another more viscous at 20 lb. per sq. in. Dr. H. C. Dickinson cleared up several points in a short talk on the fundamentals of plasticity.

Pleads for Better Grease

C. W. Spicer, in his paper entitled Better Chassis Lubricant, made a plea for a better grease, which he said could be available if car users would make known what they wanted. If use were made of a better grease, the bearing loads could be considerably raised on parts to be greased. He pointed out that only a small proportion of the cars are designed to use oil in the chassis parts, while the great majority of cars are designed at present, and perhaps for some time will continue to be so designed, so that they can be lubricated only by grease, and for these cars Mr. Spicer made the plea for a good grade of grease.

Body Problems Considered

Ventilation and Heating, Vibration and Rumble Prevention, and Color Analysis Discussed

THREE subjects that are very troublesome to the body builder and trimmer occupied the attention of the attendants at the Body Session on Wednesday afternoon, which was sponsored by the Detroit Section Body Division and presided over by C. B. Parsons, vice-chairman of that Division. The first paper was on Body Ventilation and Heating, and was presented by William Lintern, president of the Nichols Lintern Co. of Cleveland. The second was on Causes and Methods of Elimination of Vibration and Rumble, and was given by H. W. Stewart, of the Republic Paint & Varnish Works; and the third was on the measurement and specification of color and was presented by Dr. A. C. Hardy, of the Massachusetts Institute of Technology and the General Electric Co.

Motorcoach Ventilation Specifications

Mr. Lintern defined ventilation as "a sufficient volume of air to maintain healthful and comfortable conditions," and said that it will no doubt demand the attention of body builders in the future as a necessity in automobile bodies. Too little air space per passenger in the old-type flat-roof street-car aroused interest in street-car ventilation and resulted in the introduction of the arch roof, which lent itself to the adoption of exhaust devices. In some communities the health authorities indicated that a system that would approximate 10 changes of air per hour in normal operation would meet their requirements. The performance on most modern street-cars is from 10 to 20 changes per hour, hence the cars are fairly well ventilated for light and moderate loads. Motorcoach ventilation has followed the same practice to some extent, said Mr. Lintern, but his observation inclines him to think that much of the effectiveness that might be obtained is forfeited by the limited number of ventilators installed, their location, and sometimes by the screening employed.

Need Car-Ventilation Standard

As a result of experiments made on the ventilation of private passenger-car bodies, his company has reached the conclusions that roof ventilators will not be attractive to the public, and that to obtain desirable results it is necessary that some authoritative body shall set forth a standard for automobile ventilation similar to that established by the health authorities for street-cars. Such a standard should indicate the volume of air that is desirable for specified interior dimensions and the temperature of the air for a specified speed of the vehicle. Mr. Lintern believes that such a standard can be closely approximated in practice.

His company has worked on an injection system of ventilation and finds that a considerable volume of air can be injected into the body by means of a cowl ventilator located at the center of air pressure of the moving vehicle and having an area equivalent to about the area of a 4-in. circle. The volume of air injected is believed to meet the full requirements of healthful conditions and, in connection with an air heater, meets the requirement for a high degree of comfort. Adjustment of the windows by the passengers is depended upon for proper removal of the air. It was found that the engine fan does not supply a sufficient volume of fresh air and that there seems to be a liability of gases being forced into the body, especially in heavy traffic.

Problem Far from Simple

Comments made in the discussion show that the problem of suitable ventilation is anything but simple. Clayton L. Hill, of the Murray Corp. of America, said that no passenger-car body built today is properly venti-

lated. The worst condition exists in hot, humid weather when driving in a rainstorm in slow traffic. The windshield, ventilator or windows cannot be opened, "and all you do is sit in the car and steam to death." He does not believe that any device that depends upon motion of the car has any value, as often there is not enough motion to do any good; as Will Rogers said at the Annual Dinner, "we spend half of our time in an automobile waiting for a green light." Mr. Hill said he often wonders why we do not use 1 or 2 hp. from the engine that develops 75 to 100 hp. to drive a forced ventilating system; "the Book-Cadillac Hotel is not pushed around the block to get air into and out of it." He suggested the possibility of utilizing the rotating flywheel to force air into the body. There will be no trouble about getting it out, judging by the efforts being made by men in the trimming and service departments to make the bodies airtight.

In the winter there is the problem of cold-air leaks around the doors and windshield. It is necessary to control the air entering the body and pass it over a heating device. The difficulty with the inside radiator is that "if you happen to be sitting on that side of the car you certainly are going to be able to fry eggs on your knees." Some means must be found for mechanically pushing air from outside into the body; then it would be relatively easy to provide an opening through which the air could get out; that can be done by making tests to find where the greatest depression exists around the body.

Cooling Presents Difficulties

Not how to keep the car warm so much as how to keep it cool is a problem that William E. England, of the F. B. Stearns Co., pronounced to be "terrible." The big eight-cylinder engine that his company started two years ago developed a tremendous amount of heat, and in running tests at Denver in an atmospheric temperature of 90 deg. fahr., the temperature in the driver's compartment was about 130 or 140 deg. By making a false dash on each side of the U-shaped dash, the front ventilator, when open, brought air through a fine-mesh screen into the false dash and passed it through air ducts. This construction made an air-insulating device and was absolutely watertight. After installing it, a test run to California and back was made and, with an outside temperature of 90 deg., the temperature in the driver's compartment was only 110 deg.

Minimizing Body Rumble

In introducing the next speaker, Chairman Parsons stated that the company Mr. Stewart represents has done a great deal of experimental work for a number of years on the elimination of vibration and rumble in bodies, and has met with considerable success. The first part of Mr. Stewart's paper was devoted to an analysis of the various parts of the body that vibrate, the relative susceptibility of steel and aluminum panels to vibrate, absorption of vibration by wood, and the causes or sources of vibration such as the engine, tires and road conditions. By locating stethoscopes on various panels and flat surfaces of the car and at 6, 12 to 18 in. from the top of roof, it was found that the noise varies at different points in the body and that at one time a certain part emits the limit of sound, then the next moment this dies out and some other panel or the shroud or perhaps a door reaches its peak of vibration.

Of two distinct principles or methods employed to prevent body noise, one is to absorb the vibration after it has developed and the other is to place material on the inside of the panels to prevent vibration at its inception. Examples of the former are the attachment of sheets of corrugated paper, cork, composition, or of kersey cloth to the inside of the panels with an adhesive. These break up the vibrations and have high sound-absorbing quality, but are disagreeable to apply. The other method is to apply a product of a viscous nature that prevents the panel from vibrating. Pigment paint and hot asphalts have been tried, but when these dried and became hard their effectiveness was lost.

Four or five years ago research was started to develop a plastic material of an entirely different class that would not melt and run at a relatively high temperature, nor become brittle at a low temperature. After many failures, a material was produced that will withstand temperatures of 200 to 300 deg. fahr. without disagreeable effects and that remains viscous at 10 deg. below zero. This material, when it becomes set or dry, is best likened to masticated chewing-gum which never becomes brittle but is sufficiently hard not to run or be loosened by abrasive action. A method of applying this material has been worked out that is quick and satisfactory, according to Mr. Stewart, and the cost and method are on a par with the use of other materials.

Fundamental Causes of Rumble

Three fundamental causes of noise in bodies, said President Wall in the discussion, seem to be the transmission of vibrations in the chassis due to road irregularities; noise transmitted from the engine, transmission gears and rear axle; and the movement of material in the body itself. Even in a fabric body he had noticed some noise resulting from the transmission of vibration from moving parts of the chassis. The composite body may rumble slightly more than the fabric body, but is as a rule a little more quiet than the all-metal body. He thinks it is the responsibility of the chassis engineer to help in preventing rumble in the body, and said that insulation by rubber or other cushioning material between the engine and frame and between frame and body has helped. In the body itself the curved surfaces that fortunately are in style help greatly, but the body engineer should do his part to make the surfaces and to attach the body parts in such a way as to eliminate the noise that the chassis engineer does not succeed in suppressing.

Answering an inquiry by Mr. Williams, of the Hupp Motor Car Corp., Mr. Stewart told of conducting experiments to determine the best ways of applying the plastic material. Tests were made with 27 different ways on 27 different bodies that were then tested on the proving ground. It was found that on some makes of body very good results were obtained by applying the material as a belt around the edges of the panels; on other bodies a spot in the middle gave good results, while on still others a criss-cross pattern proved satisfactory, but in some cases it was necessary to apply it over the entire surface of the door or panel. The covering over the whole panel comes nearest giving 100 per cent elimination of noise. The results were tested with a stethoscope.

Answering questions by L. Clayton Hill, he said the plastic material would add approximately 5 7/8 to 6 1/2 lb. to a five-passenger body on a 115-in. wheelbase, and that the cost of the material for 58 sq. ft. for one specific insulation job was about 87 cents and the labor costs from 8 to 9 cents.

Color-Measuring Instruments

The final paper of the session dealt with the subject of color. Up to the present it has been necessary to rely upon the human eye to differentiate between or to match the thousands of colors and color shades used in the arts and industries, but at the meeting Dr. Hardy described a new instrument for the rapid and precise analyzing and measuring of colors which has been developed as the result of a research program begun several years ago at the Massachusetts Institute of Technology. Thus the uncertainty and indefiniteness of the human eye can be supplanted by a mechanical instrument having many times greater precision. The new device not only analyzes any color but computes a number by which it can be specified and differentiated from all other colors or shades.

There never has been a time when color has been employed so extensively as at present, said Dr. Hardy, and modern methods of quantity produc-

tion have introduced a problem of maintaining color standard that has not existed previously. For example, it may be desired to fabricate automobile hoods in one plant and the bodies in another. Obviously, the color of the two must match when the car is assembled, although the factories may be many miles apart. Such problems require an accurate color-measuring instrument. There are two general classes of such instruments, known as color analyzers, or spectrophotometers, and colorimeters. The former analyze the color by wave lengths and give the result in the form of a curve. The colorimeter, on the other hand, attempts to give directly the three psychological attributes of the color sensation. Both types have had limitations that have prevented their universal use. In the new instrument the shortcomings of the others have been overcome, and Dr. Hardy told of various uses to which it can be put in the automotive industry. His exposition of the instrument and its use was received with great interest.

Among Those Who Spoke at the Wednesday Afternoon Body Session

(Left to Right)—H. W. Stewart, of the Republic Paint & Varnish Works, Who Discussed Causes and Methods of Elimination of Vibration and Rumble; C. B. Parsons, Vice-Chairman of the Detroit Section Body Division, Who Presided; and William Lintern, of the Nichols Lintern Co., Who Discussed Body Ventilation in Conjunction with Heating

To Be Made Commercially

A question was asked after the conclusion of Dr. Hardy's address whether an attempt has been made to manufacture the instrument commercially, and he stated that the General Electric Co. has taken up the problem and some time, but how soon he does not know, will place on the market a commercial instrument that will be much simpler to operate than the experimental instrument described. He thinks it will be one that can be plugged into a lighting-current socket and be about the size of a bedside table, self-contained in a space about 2 ft. square.

Asked by G. Betancourt if a means had been found with the instrument to compare the sensitivity of two different persons to color, Dr. Hardy stated that none has as yet, as his efforts have been concentrated on making a machine that would be literally independent of the human eye, eliminating its disadvantages. Much work has been done, however, along the line of Mr. Betancourt's inquiry, the Bureau of Standards probably having done more than anyone else.

B. J. Lemon asked if it would be necessary to have a color expert to operate the instrument. There is a very good chance that it will not require an expert, said Dr. Hardy. He feels that the spectrophotometric curve gives a much better picture of what happens when colors are mixed than can be gained by looking at the results. In the manufacture of color filter the Eastman Kodak Co. has attacked the problem from that standpoint and the work is done usually by a man with a high-school training but no training in any science.

An important feature is the numbering of colors by their values so that the identical color can be matched or reproduced after an interval of years.

Not Confused by Weaves

E. W. Bernhard, of the Gilmer Co., raised the point that trimming material of different textures, although of the same color, seems to be of different shades, and wanted to know if the instrument would show the difference as it appears to the eye. Dr. Hardy replied that the machine has only the brains with which it is endowed and is not confused, as is the eye, by a difference in weave; it merely compares the reflected light with an arbitrary magnesium-carbon standard. But it has been found possible to match a cotton and a silk or a cotton or wool sample with a metal panel. Materials of two different colors and different blocks never will match from all angles. A surface of that sort has an infinite number of colors. The best method for a standard of comparison is to measure the color with the light reflected at an angle of 45 deg., which corresponds most closely with the way in which color of cloth is judged by eye.

Conference on Meetings Matters

The Meetings Committee met at luncheon at the Book-Cadillac on Wednesday, Jan. 16, the second day of the Annual Meeting. Plans for the ensuing year were considered, but because of the lack of a quorum no action was taken.

Subjects discussed included the following: a suitable place for holding the 1929 Summer Meeting; the type of Annual Dinner to be arranged in 1930; the advisability of having some future Summer Meeting in the form of an ocean cruise; the scheduling of one ses-

sion devoted to transportation topics at the Summer Meeting, as requested by the Transportation Committee; the time and place for the Transportation Meeting this year; the possibility of holding a National Aeronautic Meeting in Detroit in April concurrently with the Aeronautic Show, and the desirability of holding the next Annual Meeting during the week preceding the Chicago Automobile Show instead of the week following the New York Automobile Show.

Another meeting of the Meetings Committee is being planned to take place at an early date, for the purpose of reaching decisions on the matters herein mentioned.

Body Session Crowds Ballroom

Strickland and Kreusser Speak at Enjoyable Dinner and Session Staged by Body Division

THE 632 Society members and guests who assembled in the ballroom of the Book-Cadillac on the evening of Wednesday, Jan. 16, to attend the Body Dinner and the session immediately following, entered with the air of expecting a good time, remained and applauded after the manner of people enjoying a festive occasion, and departed several hours later with every appearance of having had great expectations amply realized. In addition to the men who attended the dinner, about 100 came in later to listen to the splendid addresses which made the evening a success from the viewpoint of technical and professional interest, just as the dinner and the entertainment had already made it enjoyable by furnishing an opportunity for social relaxation and intercourse. The entertainment was provided by professional dancers, a contortionist, musicians and dialogists.

The entire program for the evening was sponsored by the Detroit Section Body Division, and unqualified praise is due the Division for the excellent dinner, entertainment and session provided. W. N. Davis, of the Cadillac Motor Car Co., Chairman of the Body Division, who presided, welcomed the large audience and, expressing pleasure at the presence of W. R. Strickland, called upon him for an address as the newly-elected President of the Society.

Strickland Outlines Plans

President Strickland, after pledging himself to do his best in forwarding the work of the Society, outlined briefly the plans for the coming year. Chief among these, he said, is the proposed reorganization of the Society, which is designed to retain the advantages and many of the characteristics of the old organization but is thought by its advocates to improve on the old organization by recognizing on a National basis certain activities which will be so conducted as to secure the greatest possible cooperation from everybody.

After complimenting the Sections, which he called the bulwark of the Society, President Strickland said that the finances of the Society are in very good shape. He then mentioned some of the ways in which the Society serves the membership, as through meetings and papers, the S.A.E. JOURNAL, TRANSACTIONS and research. These various types of work, he said, would be carried on as in the past but would be extended into the new activities as fast as possible, in an endeavor to meet new conditions.

At the close of President Strickland's remarks, Chairman Davis said that the Body Division would consider it a great honor if the newly-eleced President would conduct the remainder of the session, thereby making the occasion a memorable one for the Detroit Section Body Division.

President Strickland, after a gracious tribute to Mr. Davis for his work in organizing and developing the Body Division, introduced to the audience the prominent members at the speakers' table, as follows: Dr. H. C. Dickinson, S. R. Dresser, W. T. Fishleigh, Dr. B. J. Lemon, Col. W. G. Wall, Coker F. Clarkson, C. B. Parsons, Ferdinand Jehle, J. H. Hunt, Vincent G. Apple, C. B. Whittelsey, Sr., H. M. Crane and O. T. Kreusser, the last-named being the chief speaker of the evening.

What Mr. Abstract Wants

Mr. Kreusser said that he had been asked to give a review of the 1929 cars, talking as Mr. Abstract, an imaginary personality who is representative of the average buyer and who is neither rich nor poor, lean nor fat, short nor tall, but has an automobile of which he was very proud a year ago but now wishes to trade in on a recently-announced new model, provided the trade-in allowance is satisfactory.

Mr. Kreusser prefaced his review of the 1929 cars by describing the facilities at the proving ground of the company with which he is connected for carrying on automobile test work in a comprehensive way. He pointed out that, with continuous day-and-night operation at a properly equipped proving ground, where the principal variables that enter car testing can be controlled, it is possible to develop information in about one-third of the time in which the same information could be secured on the public highway. In this way features that formerly took one or two years of development and test can be determined in four to eight months, and the results are substantiated by facts and figures free from guess and opinion.

The speaker mentioned as the various items in which the customer is interested the following: style, appearance, comfort, performance, reliability, economy and durability. He differentiated between the features that can be scientifically measured and compared and the æsthetic features, such as shape, lines, proportions, color and interior appointments, which are involved in personal opinion and seem never to follow engineering or scientific reason.

How New Cars Are Better

Coming then to his review of the 1929 cars, Mr. Kreusser said that these are longer, wider and generally larger, with prices in general the same as or less than last year, and having performance equal to or better than their predecessors. The automobile, he said, as a package containing style, comfort, performance and reliability is more merchandise for the money than ever before. The new car weighs more than the old one, the increased weight being distributed between body and chassis.

Pointing out that from the engineer's position an increase in weight is always serious when considered from a performance standpoint, Mr. Kreusser said that the acceleration, hill-climbing ability and maximum speed are as good as or better than they have been in the past. Better combustion-chamber designs, better valve porting, improved camshaft, better manifolding and in some cases twin ignition, he stated, are helping to give increased horsepower; and these improvements, in combination with properly selected gear-ratios and tire sizes, make the 1929 cars good performers, with probably some criticism that engine smoothness has suffered. Among other improvements, Mr. Kreusser mentioned a synchronized transmission development on some of the heavier cars, making gearshifting easier, and said that another accomplishment of the year is the application of improved internal brakes, apparently unaffected by wet weather, that give consistent stops with comfortable pedal-pressures. Some of these designs, he said, give consistent results for 15,000 stops before the first adjustment and 50,000 stops before relining. The brake-drum, he added, presents probably the one major problem that now stands in the way of brakes that would compare favorably with the rest of the mechanical equipment on

the car. Other problems that should receive attention, according to Mr. Kreusser, are cold-weather starting, front-wheel alignment, adequate and non-glaring headlights, and the development and improvement of safety glass.

Comfort of the rider, particularly of the driver, said Mr. Kreusser, needs serious attention. With present car-heights, windshields and seats, he said, both the tall and the short driver are uncomfortable. The advent of readily adjustable seats is greatly to be desired. The boulevard ride on many cars with soft springs and modern shock-absorbing equipment he considers good, but he pointed out that the same cars are uncomfortable on the rougher country roads except at inconveniently low speeds. He criticized the extreme hardness or softnes of seat cushions and backs and the tilt of the seat in many of the models.

Other topics which the speaker mentioned briefly in passing include doors that are difficult to close and to open; chromium-plate, often an improvement but sometimes applied without proper preparation; floorboards that cease to fit after a few months' service; the freezing hazard of the pin-tumbler in the door lock; poor material used for the floor covering in the driver's compartment; ventilation that roasts the driver in summer and freezes him in winter; weather-stripping that becomes loose; roofs that get leaky, and finish that is only skin deep. Some cars, he said, have one or two of these shortcomings, and a number have all of them.

Mr. Kreusser humorously concluded his entertaining remarks by stating that he did not intend to talk about the really marvelous things that have been developed in motor-cars and are continually being developed, as he did not care to enter into competition with the advertising man, who has even supplemented the printed word with the talking movies on behalf of the many improvements made in the cars for 1929.

Devices for Research Data

Instrumentation and the Interpretation of Indicator Charts Discussed at Engine Research Session

IN opening the Engine Research Session, held Thursday morning, Jan. 17, Chairman Alex Taub, of the Chevrolet Motor Co., said that probably all will agree that instrumentation is a most important part of automotive engineering progress and that satisfactory progress is influenced largely by the development of suitable instruments with which to obtain research data. Of the several papers that were presented, the one on The Idiosyncrasies of Valve Mechanisms and Their Causes, by Ferdinand Jehle and W. R. Spiller, of the White Motor Co., is printed in full in this issue of the S.A.E. JOURNAL, beginning on p. 133. Prepared discussion on this subject was submitted by E. W. Stewart, of William D. Gibson Co.; S. Timoshenko and W. P. Wood, of the Cook Spring Co.; and C. P. Nelson, of the L. A. Young Industries, Inc.

W. N. DAVIS AND O. T. KREUSSER, WHO WERE RESPONSIBLE FOR THE SUCCESS OF THE BODY MEETING

It was stated by Mr. Stewart that his experience confirms the statement that the causes of bad valve-performance seem to depend upon the spring characteristics in their relation to the cam characteristics. In working with designers of new engines, he said, a number of cases had occurred in which an unsatisfactory valve-train had been smoothed out successfully by changing the cam contour without making any change in the spring. In his opinion, the valve-lift curve and the spring should be very carefully worked out together, because each depends upon and affects the other.

PROGRESS LIMITED BY MATERIAL

One danger in the application of the recommendations made by the authors —to the effect that the smallest wire-sizes consistent with stress, load and frequency requirements should be used to minimize the vibration, and that the number of coils and their diameter should be as large as possible—lies in working up to stresses which are dangerous from the viewpoint of available materials, according to Mr. Stewart. He stated further that probably our ability to design ideal valve-springs has already surpassed the wire-maker's ability to produce materials which will stand up consistently. He thinks that engineers must get the best results they can as to valve surge by making every possible use of all available information, but that top stresses and stress ranges must be kept within figures which commercially obtainable wire will meet.

It was brought out by S. Timoshenko that research along other lines should be done. He thinks that the damping property of the materials may be of some importance. The question of fatigue tests of materials for springs is important because there is a condition of twist and shear stresses which perhaps are not included in the data already obtained in fatigue tests of steel. He suggested that under ordinary conditions, with mild steels, the defects in the surfaces as related to the fatigue tests are not very important but that,

in fatigue tests of steel spring-material having a high degree of hardness, not only do the defects become of great importance but the surface conditions of the steel spring-material are also important.

It was mentioned by C. P. Nelson that one cause of spring vibration is the torsional vibration of the camshaft due to its lightness and length and also caused by intermittent load and backlash in the drive.

Metallurgy of Valve Springs

W. P. Wood covered in his prepared discussion some of the metallurgical aspects of valve springs, saying that valve-spring design always has been more or less associated with the qualities and properties of the steel from which the springs were to be made. This condition placed greater responsibilities upon the steel manufacturer and the metallurgical department under whose supervision the springs are fabricated. He therefore considered at some length the factors which constitute the link between satisfactory material and proper design.

The three general types of steel available for making valve springs are hard-drawn wire, wire heat-treated before coiling, and soft wire to be heat-treated after coiling. In the case of the last two, a further decision must be made as to whether carbon or alloy steel is to be used. Regarding choice of material, in most cases the final decision is reached only after exhaustive tests. The choice is influenced largely by the stress involved and by fatigue resistance. In conclusion, he stated that he believes we are now justified in standardizing on the value of 11,500,000 lb. per sq. in. as the torsional modulus for carbon steel. In his opinion, this would make for more uniformity in design and eliminate differences in results calculated by different engineers.

The Electric Telemeter

It was stated by W. T. Donkin and H. H. Clark, authors of the paper on The Electric Telemeter and Valve-Spring Surge, that it has been realized for some time that valve-springs for poppet-valve engines come into resonance and vibrate freely in their natural periods at certain speeds within their operating range. This vibrational phenomenon has been designated as "surge." Surge points can be detected visually, as the vibrating spring has a fuzzy or blurred appearance, and audibly, because the vibrating spring emits a tone. However, it is all but impossible to evaluate the magnitude of the surge by simple visual and audible detection, and to determine what happens when the spring seems not to be surging. To be of real value, a surge investigation should include some concrete record and should indicate what effect the surge has upon the stress conditions in the spring.

The electric telemeter presents an excellent means for investigating the phenomenon of valve-spring surge. Basically, the telemeter is composed of two differentially connected stacks of thin carbon discs arranged so that, when the apparatus is subjected to strain, the pressure is increased on one stack and decreased on the other. Each stack forms one arm of a Wheatstone's bridge, and the resistances of the stacks vary with the pressure on them, thus slightly upsetting the balance of the bridge. If an oscillograph galvanometer-element be substituted for the usual bridging instrument, the arrangement will be found suitable for making photographic records.

To study valve-spring surge, the telemeter is connected across the points of a stiff C-spring, one end of which is held against the valve-spring in such a way that vibrations of the spring are transferred to the C-spring and thence to the telemeter. This equipment has made it possible to identify the cause of valve-spring surge as a resonant condition at certain speeds.

Except at low engine-speeds, the stress conditions of a spring having resonant points are much worse than is indicated by the conventional stress-formula, both as to degree and as to the rapidity of the stress cycle. Surge and stress conditions are improved by designing the springs for high frequency, and by making the pitch variable so that the frequency is variable as the valve lifts, thus eliminating resonance.

Main Features Discussed

H. A. Huebotter discussed valve-spring surge academically in connection with a chart in which a curve representing valve lift and a curve showing the rate of change in valve lift were shown, plotted against the distance a stress wave is transmitted through the spring while the valve is open. The chart showed the elastic vibrations in a helical valve-spring which are induced by the motion of the valve, and he described the method by which the chart was prepared.

Mr. Timoshenko said in part that he thinks the matter of the vibration of the telemeter instrument is of practical importance because, if the frequency of the instrument itself enters into the vibrations which are being measured, some erroneous results may be obtained. He said that the frequency is not very high; for instance, in the telemeter designed by Peters, the frequency is about 500 vibrations per sec. and another type of telemeter used in Germany of which he knows had a frequency of 200 vibrations per sec. He also mentioned a newly developed telemeter which he has seen in Germany that has a frequency of 1000 vibrations per sec. and can be used for measurements of very high frequency. In experimenting with the telemeter, he said, it was found necessary to keep the instrument under the influence of the current for about 5 min. before starting to make the records, because, otherwise, the results were unreliable.

Mr. Stewart characterized as broad and sweeping the statement by Donkin and Clark to the effect that a spring breaks because of the stresses set up in it and that no spring breaks when it has a lower actual stress than a similar spring which stands up in service. If all wire were perfect as to physical characteristics, microstructure, condition of surface and hardness, it would perhaps be safe, he said, to draw such a conclusion. To be sure, when wire is not perfect, breakage results from localized stresses set up at certain points of weakness under fatigue conditions, such as scratches, nicks from tools, segregation pockets and other things; but he is of the opinion that imperfect materials are responsible for more breakage than can be charged to surge.

Indicator-Card Interpretation

In the paper by R. N. Janeway it was stated that in the internal-combustion engine the speeds are relatively terrific, pressure is developed with explosive violence, and the high temperatures further complicate the problem of developing an indicator mechanism that will produce reasonably accurate diagrams. Much ingenious effort has been attracted to this problem, and the results have been gratifying in that a number of satisfactory instruments are now available that can be depended upon to secure the record. But the interpretation of this record is a problem which, compared with the interpretation of an indicator card from a steam engine, is like a differential equation compared with a problem in elementary algebra. The reason is that we are dealing with a medium which undergoes chemical as well as physical changes, with consequent variation in composition and in the manner and magnitude of energy liberation. Further, the author endeavored in his paper to reduce the problem of interpretation to such form that the vital information can be extracted from the indicator card with minimum effort.

Mr. Janeway discussed the thermodynamic characteristics and the combustion efficiency mathematically, including also an interpretation of heat balance. The shock effect of combustion was also treated. He stated that the item of outstanding importance in the card interpretation is the nature of heat liberation. By means of the procedure he presented, this process is not only quantitatively evaluated but the heat liberation during the normal combustion-period and during expan-

sion are separated so that the extent of the loss due to after-burning is revealed. The procedure was illustrated by complete analysis of a sample card, and forms for tabulation and calculation were given whereby the work of interpretation can be reduced to routine.

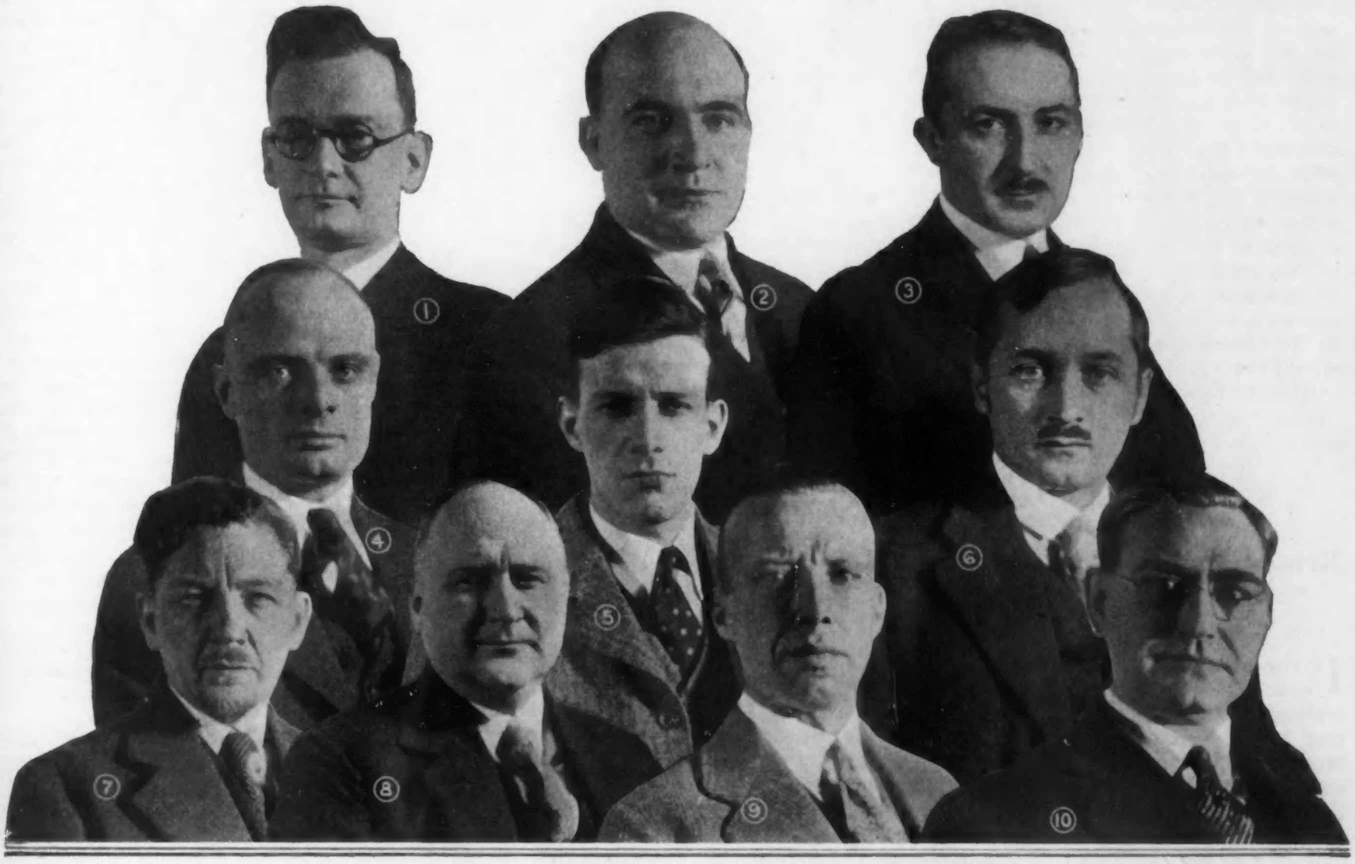
Effects of Leakage and Dissociation

In discussing Mr. Janeway's paper, C. Fayette Taylor, of the Massachusetts Institute of Technology, mentioned that one attractive feature of this method of analyzing indicator cards from a thermodynamic viewpoint is that it should be easily understood by persons who are not particularly expert in handling thermodynamic relations. He said that the high value of the exponent obtained for the first part of the expansion stroke, together with the considerable reduction of this value for the latter part of the expansion, seems to indicate considerable leakage. His thought is that, if considerable leakage were present, this might explain the apparently sudden appearance of after-burning toward the end of the stroke.

H. K. Cummings read discussion of the Janeway paper that was prepared by F. C. Marvin, Jr., associate physicist at the Bureau of Standards, in which Mr. Marvin referred to the effects of dissociation at high temperature and the recombination and after-burning which follow on the expansion stroke. At temperatures in the neighborhood of 4000 deg. fahr., absolute, there is certain to be some dissociation, especially of carbon dioxide and, as indicated by the sample card, after-burning persists until the exhaust-valve opens. Therefore, in his opinion, the composition of the expanding gases and consequently the value of R in the basic equation $PV=WRT$ are variables that do not reach the values assigned to them in the paper until the end of the expansion stroke.

Mr. Marvin suggested also that, in view of the uncertainty as to just how far combustion has progressed at the various points in the diagram, some rather arbitrary assumptions must perhaps be made regarding heat liberation. Mr. Janeway interprets the high exponent at the beginning of expansion and the low exponent near the end to mean no heat liberation just after maximum pressure, but marked after-burning near the end of the stroke. Mr. Marvin thinks, however, that these exponents might indicate instead very high heat-loss to the jackets near the top of the stroke with decreasing loss later, accompanied throughout by liberation of heat. In his opinion, a more accurate treatment of expansion would be to assume complete inflammation of the charge at the point of maximum pressure and chemical equilibrium of the products thereafter according to the method used by Goodenough and Baker in their analysis of ideal cycles. This would require that the temperature-energy diagram be plotted for the variable equilibrium-mixture rather than the constant-combustion products mixture described by Mr. Janeway.

Dr. H. C. Dickinson stated that numerous indicator cards had been taken at the Bureau of Standards using a similar type of instrument to that described by Mr. Janeway and that these were analyzed. In many of



Speakers and Discussers at the Engine-Research Session

Ferdinand Jehle (1), of the White Motor Co., Who Presented His Paper on Idiosyncrasies of Valve Mechanisms and Their Causes, Prepared Jointly with W. R. Spiller (4); W. T. Donkin (2), of the Cleveland Wire Spring Co., Who Submitted the Paper on the Electric Telemeter and Valve-Spring Surge, Prepared Jointly with H. H. Clark (5); Robert Janeway (3), Consulting Engineer, Who Presented His Paper on the Interpretation of the Indicator Card; and K. J. DeJuhasz (6), Who Discussed the DeJuhasz Indicator; S. Timoshenko (7) and W. P. Wood (8), of the Cook Spring Co.; G. P. Nelson (9), of the L. A. Young Industries, Inc.; and E. W. Stewart (10), of the William D. Gibson Co., Who Discussed the Papers on Valve Springs

these cards, he said, none of the sudden changes of exponents which appeared on the card described by Mr. Janeway were noticeable. They showed the exponent on compression to be fairly consistent, and this was also true of the exponent on expansion.

In reply to Professor Taylor's comment on leakage and Mr. Marvin's remarks as to dissociation, Mr. Janeway acknowledged both to be true. He stated that the high value of the exponent at the beginning of expansion was undoubtedly exaggerated because of leakage, as would be expected from the low value of the exponent at the end of compression; and, further, that he did estimate the effect of dissociation and found that, for the average range of maximum temperature, its effect does not seem worth taking into consideration, especially as recombination usually will take place rather quickly on expansion as the temperature falls. In his belief, which was supported by Dr. Dickinson's mention of his experience with the same type of indicator, the difference in the cards can be accounted for by the differences in the characteristics of the engines on which the experiments are made.

The evolution of K. J. De Juhasz's high-speed engine indicator was described from its conception in 1915 to its present finished form. The apparatus is characterized, according to the inventor, by the absence of all electrical and optical complications, a diagram of ample size is drawn by pencil on paper, the device is of rugged construction, is of small weight and dimensions and has easy mountability. It was claimed that these features render it eminently suitable for routine tests in the laboratory, for instructional purposes, and generally for research on all kinds of periodically recurring pressure phenomena.

According to Mr. De Juhasz, the device records, by a point-to-point method, all such phenomena up to the highest speeds used in practice. Indicator cards were obtained on an engine running at 6000 r.p.m., and the accuracy was said to be the same as that of a normal indicator on an extremely slow-running engine. The indicator is entirely mechanical in action. Because of its light weight and small over-all dimensions, it is easily applicable to any engine without interfering with the engine's regular operation. Lantern slides of actual installations and of sample cards were shown.

End of Shimmy in Sight

Remedial Measures Described—Car Vibration, Wheel Alignment and Brake-Lining Testing Discussed

IF the results of the study of shimmy and of the experimental work described in the paper by J. C. Vincent and W. R. Griswold, of the Packard Motor Car Co., at the Chassis Session on Thursday afternoon prove applicable to all cars and as effective in preventing front-end phenomena as was indicated at the meeting, it seems likely that meeting committees in the future will be confronted with the question what to substitute at chassis sessions for this topic, which has been a pet ever since the advent of balloon tires. Importance of the work is indicated in the concluding words of the paper:

> Front-end suspensions are not nearly as bad as some investigators have indicated, and it is unnecessary to make any revolutionary changes to obtain desired results. We are certain that, by the means we describe, even better results are obtainable than previously with high-pressure tires.

In the unavoidable absence of Mr. Vincent, the paper was presented by Mr. Griswold. Earl Gunn, of the Nash Motors Co., served as chairman of the session. H. A. Huebotter, in discussion of the paper, gave an interesting demonstration of gyroscopic action with a small model. The paper elicited much other discussion, in the course of which it became evident that some speakers were unconvinced that the Packard investigators have found a real remedy but, on the contrary, hold that shimmy, tramp, steering-wheel kick and the like cannot be eliminated except by the adoption of independently sprung front wheels.

W. S. James, research engineer of the Studebaker Corp. of America, presented the first paper, on Testing Brake-Lining for Uniformity; F. F. Kishline, experimental engineer of the Graham-Paige Motors Corp., delivered his Notes on Frame and Body Road-Vibration, followed by prepared discussion of the subject by W. C. Keys, of the United States Rubber Co.; and Prof. J. M. Nickelsen made a progress report of the Research Subcommittee on Front-Wheel Alignment.

Steering Geometry Improved

A large part of the Vincent and Griswold paper was devoted to a review of the steering troubles that were so greatly aggravated by the introduction of low-pressure tires and to an analysis of gyroscopic forces set up by the rotating front wheels when their plane of rotation is altered by turning of the steering-knuckles on the steering-knuckle pivots or by vertical oscillation of the front axle. Six means that may be employed beneficially to suppress or reduce shimmy were enumerated, but, although all of these means have been employed, shimmy and tramp have persisted, because the exciting forces have dominated.

One way of reducing the magnitude of these forces is to keep the unbalance of the wheels and the tires at the lowest possible limit. A more important means, it was indicated, is to design the steering mechanism with as nearly correct geometry as is attainable. Conventional arrangement of the steering linkage, axle, spring and spring-shackle was shown diagramatically in some of the numerous slides used to illustrate the points in the paper. As is well known, when the spring is hinged at the front end and shackled at the rear end, the ball on the steering-knuckle lever moves in a reverse arc from that which the front end of the drag-link must describe if no displacement of the wheel on the steering-knuckle pivot is to occur when the spring is compressed. Since it is impossible for the two to describe different arcs, the plane of the wheels must change, the steering-gear must move, or there must be a compromise turning of the wheels on their pivots and some movements of the steering-gear. In any case, it was pointed out, some gyroscopic forces are set up when the car is moving at speed. This error in geometry was stated in the paper to have a decided effect in accentuating shimmy or of making it easier for the shimmy to start.

Special Bracket Stops Wheel Kick

Very nearly correct steering geometry is secured by shackling the springs at the front instead of the rear end, and, by introducing suitable damping forces, all possibility of shimmying can be eliminated, according to the authors of the paper. In practice, however, it is almost impossible to make a steering system that is geometrically perfect, and damping forces are difficult to control. To introduce a damping force that acts automatically to delay the precession of the wheels without increasing the steering effort, the rear end of the left spring is mounted by the Packard engineers in a trunnion bracket the particular feature of which is that it is yieldable from its central position but is self-centering. This permits the axle to move slightly fore and aft from its normal position under the influence of a gyroscopic couple acting through the trunnion but reacted against by the friction of the steering-gear. Any such movement is accompanied by damping forces set up in the bracket.

Wheel kick is eliminated by the tendency of the tangential force caused by

the wheel striking an obstruction, and tending to move the axle backward, to be neutralized by the reaction of the drag-link due to precession of the wheel to the right, and tending to move the axle forward.

By this arrangement, according to the authors, the gyroscopic couple and the horizontal couple due to the tangential force are always proportional to each other, and wheel deflection is reduced to a very small value. It is not necessary that these two forces completely neutralize each other; if the residual force is less than the friction in the steering-gear, no kick will be felt on the steering-wheel.

With a simple apparatus consisting of a bicycle-type wheel mounted on a small steering-knuckle attached at one end of a steel bar supported pivotally in the middle, Mr. Huebotter gave a clear demonstration of the gyroscopic forces set up by the interaction of the front wheels and the axle of an automobile. He spun the wheel on its spindle, then by tilting the free end of the axle upward or downward showed how the change in position of the wheel spindle caused precession of the wheel to the right or left; also, how turning the rotating wheel to right or left on the steering-knuckle pivot caused the axle to tilt.

From this, Mr. Huebotter went on to analyze the forces set up in a motor-car by the rotating wheels when turned to right or left to steer the car, or when the axle is tilted as one of the wheels passes over a road bump. The principal fact that the demonstration was meant to establish is that front-wheel shimmy is a natural consequence of the conventional axle design. So long as a heavy axle-assembly is free to oscillate between soft springs and softer balloon tires, the conditions for shimmy are ideal, he said, and the most direct way to cure the shimmy evil, he asserted, is to discard the axle bed and to mount the wheels upon independently sprung supports.

SPEAKERS AT THE CHASSIS SESSION

(Upper Row, Left to Right) W. R. Griswold, of the Packard Motor Car Co., Who Presented a Paper, Prepared Jointly with J. G. Vincent, on Aspects of Motor-Car Engineering Associated with Balloon Tires; Earl Gunn, of the Nash Motors Co., Who Presided; W. S. James, of the Studebaker Corp., Who Discussed the Testing of Brake Lining

(Lower Row, Left to Right) F. F. Kishline, of the Graham-Paige Motors Corp., Who Submitted Notes on Frame and Body Road-Vibration; J. M. Nickelsen, of the University of Michigan, Who Presented the Report of the Research Subcommittee on Front-Wheel Alignment; and W. C. Keys, of the United States Rubber Co., Who Discussed Mr. Kishline's Paper

INDEPENDENT SPRINGING DEBATED

As might be expected, the conclusion stated by Mr. Huebotter started a debate on the moot question of inde-

pendently sprung front wheels. F. F. Chandler, of the Ross Gear & Tool Co., expressed extreme doubt if the damping device shown and described by Mr. Griswold will do all that he claims, and said that it is a practical impossibility to control the forces with the present conventional construction. When the axle rocks, the angle of the wheel spindles is changed, and this is the only thing, he said, that will start the precessional movement of the wheels. If, however, a gyrostat is moved in any direction but the axis on which it is rotating is kept parallel with the axis on which it was previously rotating, no precessional movement will be started. With independently sprung wheels the axis of the wheel remains exactly parallel with its original position notwithstanding the up and down movements, consequently road conditions will not start gyroscopic motion. And if such a mounting is not connected through a front axle to the opposite side of the car, there will be no contributing action on the other side.

Chairman Gunn mentioned that, whereas a year ago many European cars with independently sprung wheels were exhibited at the Paris Salon, only one or two were shown at the Salon last December, and inquiries among dealers as to the reason brought out the statement that, while those cars did not shimmy, they rode so hard that the public would not have them

William E. England, of the F. B. Stearns Co., testified to the efficacy of the device described by Mr. Griswold. After wrestling with the shimmy problem until arriving last year at the point where all the trouble except wheel kick had been overcome, his company tried the construction shown by Mr. Griswold and found that it took out 90 to 95 per cent of the wheel kick on the car that was worst in this respect. To avoid shimmy conditions it is necessary, asserted Mr. England, to stiffen the chassis frame in every direction in which it is possible for the front axle to twist the frame. No matter how deep the side rails are, the results cannot be accomplished unless they are tied together with torsionally stiff cross-members, not tubes. It is surprising, he said, how much the rear wheels have to do with twisting of the frame. For the last year the company has had an automobile in which the engine is mounted so that it is movable back and forth but everything else is tight.

Having had the opportunity of riding in and driving Packard cars equipped with the device, J. E. Hale, of the Firestone Tire & Rubber Co., said that he knows they will do everything that is claimed for them.

Front-End Vibration

Allied with the problem of shimmy is that of Frame and Body Road-Vibrations, on which Mr. Kishline presented some notes with the object of stimulating discussion and leading possibly to the presentation of a comprehensive paper on the subject by some competent member of the Society. The vibrations to which reference was made were lateral vibration of the front end of the body and shaking of the radiator, head-lamps and fenders. These disturbances do not have their origin in shimmy or tramping periods but start from an irregular road surface. As relative motion of parts securely attached to the frame occurs, the first thought is that the frame should be stiffened, but as a rule it has been found that the stiffer the frame is the more violently the parts shake. And in general, the longer the wheelbase is, the less noticeable the shaking becomes. By reproducing the action in a car standing on the floor and without the wheels rotating, the frequency of application of the disturbing force was found to correspond closely with the natural bouncing period of the tires. Vibration has been taken completely out of a car by reducing the air pressure in the tires, but this produced tramping at the higher car-speeds.

It has been definitely determined, continued Mr. Kishline, that a neutral or nodal point exists somewhere in the length of each car; it does not seem to correspond to the position of the rear engine-support nor to the position of frame cross-members but varies in different designs.

Torsional stiffness of the chassis in a number of makes and types of car has been found to be approximately one-third that of the car when the body is fastened securely to the frame.

Factors Contributing to Nervousness

Low-speed nervousness, shimmy or whatever it is called, is largely the result of instability of the frame, asserted W. C. Keys. In tests made with a Cadillac frame having three tubular cross-members and with an old Marmon frame, the former was found to have four times as much stiffness as the latter. Another test with a frame having tubular cross-members and which was fastened down at three corners, showed six times as much stiffness when a body was bolted securely to the frame as without the body, and eleven times as much stiffness when the body and engine were in place.

Many factors contribute to the various oscillations of the front part of the car, and these have different values in different cars. Varying results have been obtained by altering the caster angle, the engine mountings and the spring shackles. A tubular cross-member at the front end of the side rails, Mr. Keys believes, is useful in stiffening the frame and reducing or eliminating nervousness, and a similar member at the rear of the engine has done considerable good. Decidedly beneficial effects were secured by use of an engine mounting that prevented appreciable lateral movement of the engine. Elimination of backlash in the steering-gear and steering linkage also resulted in decided improvement.

Testing Lining for Uniformity

Lack of uniformity in brake-lining is one of the greatest obstacles to the production of better and more reliable braking systems, according to W. S. James, who gave an interesting paper on the subject. He does not think the car manufacturer can tell the lining manufacturer how to make his brake-lining or that he can furnish specifications of the various properties it should have, but, having found a roll of lining that gives no trouble, he can test all future lining against the former and so make sure of uniformity within limits. Although several properties can serve as identity tests, no method of testing that will determine in advance what the actual performance of a brake-lining will be in a car has been forthcoming.

For this reason, Mr. James proposed that, by means of simple "go" and "no go" tests, all receipts of lining be compared for uniformity with a selected satisfactory sample. A relatively simple machine constructed for this purpose tests every foot of brake-lining at the rate of 30 ft. per min. for surface coefficient of friction, stretch, thickness, width, and bleeding when heated. The indications of the machine are automatic and the machine stops when definite limits are exceeded. In one case, according to the speaker, testing has been continued over a period of more than six months at an expenditure of less time and cost than was expected and with gratifying results as to uniformity of product and inspiration to the producer of the lining.

In answer to an inquiry, Mr. James stated that the machine consists of a driving mechanism to draw the lining under a sliding shoe which loads the lining vertically, and the friction of the shoe on the lining is resisted by horizontal springs. The lining first passes through a heating element, then under the shoe, and next over a pair of rolls that measure the thickness and the width. Stretch is measured by counters that roll with the lining before and after it passes under the friction shoe. Laughter was provoked when he said that, as the material runs through the machine, the increase in length due to stretching is approximately enough to pay for the cost of the test.

A. J. Scaife referred to the different methods of making brake-lining and wanted to know if the desired properties of the lining do not depend to a considerable extent on whether it is to

be used on a rear-wheel, high-pressure, slow-moving drum or on a propeller-shaft, low-pressure, high-speed brake-drum. Chairman Dunn reminded the hearers that Mr. James had pointed out that the testing was not to determine the actual properties of linings but to compare them with a standard, and that the results are to be applied to the particular place where the lining is to be used.

Front-Wheel Alignment

Progress made by the Society's Subcommittee on Front-Wheel Alignment was reported upon by Prof. J. M. Nickelsen, of the University of Michigan. This is a research matter, undertaken by a committee because of the divergence of views relating to toe-in, camber, caster, steering-knuckle-pivot inclination and turning radius. The first undertaking was to secure data on these factors in new cars as they are purchased and to check these and record the variations with mileage of the cars in service. It was then proposed to investigate the effect of wheel alignment on steering, road control and tire wear, and to investigate two general types of wheel-aligning instruments, those that check the manufacturers' specifications and those that ignore them.

After describing the means adopted to measure the factors mentioned, and stating that information was obtained from virtually all car manufacturers giving the engineering specifications on their cars, that readings are taken on the cars as purchased and after every 5000 miles of operation at the General Motors Proving Grounds, Professor Nickelsen stated that the data collected up to this time clearly indicate that few companies attempt to check front-wheel alignment of the cars before they leave the factory. The data also indicate clearly that the cars do not hold the original front-wheel-alignment for any length of time in service.

No definite program has been outlined as yet for ascertaining the effect of front-wheel adjustments on tire wear, but several tire companies have promised to cooperate in this phase of the Committee's work. However, information already gained indicates, said Professor Nickelsen, that such tests will be of little value without first being able to hold the wheels to definite adjustments.

More work on turning radius is contemplated and thought is being given to working out an instrument that will record the turning angle through the entire range instead of taking one reading. Layouts already made of standard axles, which show the theoretical angles throughout the turning range, indicate 1 deg. or less of error throughout the range, and in general about ½ deg. of error for less than 20 deg. of turning. The Committee feels that even a small error may cause excessive tire wear on curves taken at high speed. The Committee also feels that it is desirable to investigate the various devices on the market which check front-wheel alignment without regard to manufacturers' specifications. Nearly all car manufacturers now object to having their cars subjected in service stations to changes as prescribed by such instruments.

B. J. Lemon, of the United States Rubber Co., bespoke an interest in this research, saying that the tire industry started the project because it has been called upon to bear the burden of tire wear due to misalignment. The trouble in the field has been that some man who tested alignment with some of the instruments for the purpose would lay the blame on the tires if he was a friend of the car maker, or on the car if he was a friend of the tire manufacturer or distributer. What is desired is some contributions from men who are interested in the subject, he said, so that the Committee can do a thorough and practical job.

Chrysler Laboratories Visited

Talks on Engineering Advancement by Zeder and Woolson and Uptodate Testing Equipment Inspected

CONVEYING something like 700 members and guests from the Book-Cadillac Hotel to the Chrysler plant, Thursday evening, Jan. 17, was simply a matter of one six-wheel motorcoach after another; and a good thing too, because motorcoach riding under such conditions is guaranteed to solve the problems of transportation for the stranger within the city's gates. All he needs to know is where to "on at" and where to "off at," and the motorcoaches and their drivers do the rest.

Arrived at the plant the delegates were ushered into the display room of the engineering building, where 25 automobiles can be exhibited at one time, and found it at once a bower of growing hot-house plants and a lecture hall surrounded by a fringe of all the latest models of Chrysler cars, immaculate to the last degree. Members of the Chrysler Engineers' Club constituted the reception committee and very shortly made everybody feel at home.

The program called for addresses by two Chrysler officials, the showing of motion pictures of the activities in the laboratories to familiarize the visitors with what they were to see, and an inspection trip throughout the building. When all were seated, Philip T. Kent, of the Chrysler organization, called the meeting to order and welcomed the guests in behalf of the Engineers' Club. He introduced to the audience the several Chrysler officials who were seated on the rostrum, and then called upon Fred M. Zeder, vice-president in charge of engineering, for remarks.

Engineering Ideals Victorious

In his address Mr. Zeder welcomed the guests and said in part that the automobile business today has resolved itself into a battle of engineering, because, in the final analysis, it all resolves back to the product. Therefore, engineers should be honest in their profession and in the interpretation of the fundamental principles of engineering science as applied to design. Engineering of the product has in the past been dominated by the management; by the production man, whose viewpoint is and should be his tools, dies, jigs and fixtures, his direct labor, his overhead and his capital investment; by the purchasing man, whose viewpoint is and should be the cost of the material entering into that product; and by other members of the organization's personnel. Naturally, cut-and-dried, high-and-mighty and guesswork methods were employed. With the help of a good advertising agency that studied human psychology and had the peculiar knack of converting a mechanical defect into a sales asset, the companies got by. But those methods are not fair. The engineer must assert himself. Successful companies today are entrusting this phase of their business to the engineers, and the engineer is coming into his own. A few years ago, the engineer was just a tool for the other fellow. He had no place in the factory. He was housed any place, and "I know whereof I speak," said Mr. Zeder. Perhaps that was a blessing in disguise, because engineers raised such a howl that today each company is trying to outdo the others in providing their engineers with suitable housing and with laboratory equipment.

He remembered the days, he said, when the industry virtually was organized on trade names such as "Simplex," "Duplex," and other complexes; and when we wanted to specify heat-treatments we had no pyrometers, no real furnaces and no carbonizing compounds, but used bone. Oils, greases, paints, and everything else were in the same category; it was chaos, and graft was rife. For instance, on ana-

HIGHLIGHTS AT THE CHRYSLER ENGINEERING LABORATORY SESSION

More Than 600 Members and Guests Attended the Chrysler Session on Thursday Evening, Which Was Followed by an Inspection of the Various Laboratories

HOSTS AT AND VIEWS OF THE CHRYSLER ENGINEERING LABORATORY

(1) O. R. Skelton, Executive Engineer; (2) Fred M. Zeder, Vice-President in Charge of Engineering, Who Discussed the Importance of Engineering; (3) Carl Breer, Executive Engineer; (4) H. T. Woolson, Chief Engineer, Who Discussed Modern Engineering Organization; and (5) P. J. Kent, President of the Chrysler Engineers' Club, Who Presided

lyzing the quenching medium for which we were paying $10 per barrel, we found it to be nothing but water. But thanks to the Society of Automotive Engineers and to its Standards Committee, such conditions have been eliminated and the Society now serves as a clearing house for all of our laboratory findings.

The blueprint is nothing more than the engineers method of shorthand writing, continued Mr. Zeder. To write the specifications of a connecting-rod, for example, would require at least a dozen sheets of closely typewritten matter. Engineers now talk the same language, and there is no mystery about automotive engineering. The design of a motor-car is nothing more than a composite problem of thermodynamics, metallurgy and mechanics.

Transportation is a fundamental of civilization. The engineer today plays a most vital part in our very existence, and he should be honest in his profession. There is no monopoly on brains, and no substitute for hard work. When we can get a group of men cooperating, coordinating, and avoiding petty jealousies, any problem can be solved. The function of the Society has been to get men together and to get them to work together. Consequently, concluded Mr. Zeder, engineers have finally gained recognition and the engineer has now come into his own.

Modern Engineering Organization

Harry T. Woolson, chief engineer, referred to the new engineering building of Chrysler Motors, Inc., which was opened for service July 2, 1928, as evidence of the high position to which engineering has been elevated by the management. He praised the engineering leadership that had thus been demonstrated, and said that the personnel of the engineering department now includes 850 individuals.

In Mr. Woolson's opinion, an important element tending toward the successful functioning of any group of workers is a suitable atmosphere in which to work. He was reminded, he said, of how plants thrive and how rapidly they develop in the warm moist atmosphere of a hot-house, and he credited a large part of the success of the engineering department to the creation of an atmosphere favorable to development, one in which the workers do not need to worry about their jobs and their chances for advancement, and are given credit for their ideas.

The cultivation of a high degree of dissatisfaction with the product, regardless of how well it may compare with competitive products, was urged by Mr. Woolson as necessary to accomplish continuous improvement. He remarked that every engineering department should have a division engaged in research problems exclusively, so that the products of five or possibly ten years hence can be visualized now to the greatest possible extent. Such a division, entirely divorced from the design division, is provided for in the Chrysler scheme. A few years ago, engineering was supposed to deal only with the oily, grimy parts of a car, but engineering now embraces the finer arts. So, a well-equipped art department having a high-grade personnel is now a part of the organization and it is considered of major importance.

Specialized Work a Feature

The management has found it desirable to have its engineers specialize, rather than have an individual cover several subjects, thus enabling an engineer to carry on thorough and extensive investigations in a given subject. For example, the speaker said that the subject of rubber is becoming of greater and greater automotive importance and demands the work of a specialist, and that a company can well afford to employ specialists to check specifications of materials bought in large quantities and to improve design. Pistons, valve springs, radiation, cooling, engine vibration and riding comfort have all been improved in this manner in the Chrysler plant. The ideas and recommendations of the specialists all go into the design-department hopper and are reflected in production as soon as possible.

Great care was used in locating noise and vibration-producing apparatus so that interference with the work would be minimized. Drafting rooms are lighted by the indirect system, to eliminate shadows. Physical, mechanical, metallurgical and chemical laboratories equipped with modern testing apparatus are located on the first floor. Here also are the chassis and engine dynamometers, and the cold room where tests can be made at 20 deg. fahr. below zero in a 40-m.p.h. gale produced by blowers. A battery of water brakes in the powerplant section is used for making full-power breakdown tests. Washed air, free from carbon monoxide, is supplied to the dynamometer rooms, and it is changed every 1½ min.

The service garage is on the second floor, and the experimental-chassis-assembly department is on the third, where tests are made of rear axles, propeller-shafts, brakes and transmissions. A large portion of the second floor is occupied by the display room, auditorium, and offices. The experimental-body-construction department is on the fourth floor, as well as the paint shop. Design and development work, and various specialized research work, are conducted on the fifth floor.

Motion Pictures and Inspections

Following the several reels of motion pictures showing the apparatus, testing procedure and other activities, the visitors were divided into small groups, each in charge of a competent guide, and conducted throughout the building. Great interest was manifest, especially in the laboratory equipment, the dynamometers, and the cold room. Many were the expressions of approbation and of interest in the special and unique features exhibited. It was a well-satisfied crowd that motorcoached back to the hotel, and there is scarcely a doubt that many a member of it was thinking *how* he would like to have some laboratories like those for his very own.

Factors of Engine Operation

Doped Fuels and Economy, High-Compression Ignition Requirements, and Dual Carbureters Considered

So much in the way of papers and discussion on engines was forthcoming for the meeting that two Engine Sessions were scheduled, one on Friday forenoon and the other in the afternoon of the same day, and both were well attended. At the forenoon session, at which O. C. Berry presided as chairman, three papers on different factors in engine operation were presented. Chairman Berry, in opening the meeting, said that he did not know when he had seen a program that gave promise of more interest and of more good information than the papers scheduled. He was impressed with the fact that from year to year the Society is able to get papers that are more and more to the point. Men who have had trouble and got out, thereby learning a great deal, are loosening up a little more, he said, and instead of holding important discussions in groups of two or three, some are coming out with their experience in open meetings. Often the time that the best information comes out is when men become a little peeved and have difficulty in expressing themselves in terms that the ladies taking the notes on the stenotype machines probably want to hear.

Doped-Fuel Economy Analyzed

The relation of high compression to operating cost when using antiknock fuel or ordinary motor gasoline was

analyzed by L. C. Lichty, assistant professor of mechanical engineering at Yale University. By means of charts, tables and formulas he endeavored to show that, without taking into consideration the cost of carbon removal, there is a range of compression ratios below which it does not pay to use doped fuels at a differential of 3 cents per gal. and above which it is profitable to use antiknock fuels. For example, a 6-to-1 compression-ratio would not justify the extra price with ordinary gasoline selling at any price up to 30 cents per gal., but a 6.5-to-1 ratio would justify it at any price above 21 cents, and a 7-to-1 ratio would justify it with gasoline selling at 18 cents per gal. or more. As, however, a car can be operated a greater mileage with doped fuel than with standard motor gasoline before carbon removal becomes necessary, this tends to offset the extra cost of the special fuel. Furthermore, as the compression is increased, more miles per gallon of fuel are obtained, hence the fuel cost per mile is decreased, as Professor Lichty showed by tables.

After discussing other factors of engine and car performance, such as gear ratios and partial and full-load conditions, conclusions were drawn that (*a*) carbon-removal saving resulting from use of a fixed doped fuel is highest for the lowest compression-ratio; (*b*) fuel saving is directly proportional to the cost of the fuel for any compression ratio; (*c*) for a given dope, carbon-removal saving will vary only with the cost of removing the carbon; (*d*) with low fuel-costs, no saving seems to result from use of doped fuels with present compression-ratios; (*e*) with higher fuel-costs, the net saving becomes considerable; (*f*) with a compression ratio of 5 to 1, the economy of doped fuel depends upon carbon-removal saving; (*g*) fuel economy from higher compression with existing gear-ratios will be less under actual operating conditions at the lower speeds than would be expected from a full-load analysis; and (*h*) expected fuel economy, better performance at the higher speeds, higher maximum car-speed, and lower engine-speeds can be obtained by decreasing the gear reduction when decreasing the compression.

Theory and Practice Differ

When the obvious theory underlying a performance of this kind is studied and the results are compared with the actual results obtained from an engine designed to give the desired performance, said Chairman Berry, in commenting on Professor Lichty's analysis, we often wonder whether the book is correct. Usually it is found that the study is offset by some factor that had not been taken into account. Some tests that he had followed seemed to indicate that the increase in economy when using high compression and doped fuel was greater than theoretical analysis showed it should be. Dynamometer studies also showed a comparatively small increase in power at the lower speeds due to higher compression-ratio and a very large increase of power at the higher speeds. He does not know, he said, how theory accounts for this.

Regarding carbon-removal saving, D. P. Barnard, 4th, of the Standard Oil Co. of Indiana, said that as compression is lowered the mileage that can be obtained between top overhauls is determined more by the life of the exhaust-valves or some other part of the engine than by the quantity of carbon that accumulates. As compression is raised, there is a definite tendency toward increased life of the exhaust-valves and a decreased cost of overhaul which he thinks was not allowed for in the paper. Charles A. Winslow, of Vallejo, Calif., said that probably the carbon-removal period would depend more on the kind of lubricating oil used and the condition of the pistons and piston-rings than on the kind of fuel.

Professor Lichty pointed out that the question is not whether the carbon is formed from fuel or oil, but is how soon its removal becomes necessary when using an antiknock fuel because of the knocking that occurs when carbon has accumulated. As the extra mileage increases, the carbon-removal curve approaches maximum value.

Ignition for High-Speed-Engines

Some of the requirements that high-compression high-speed engines impose on the ignition system were dealt with by T. J. Fitzsimmons, of the Delco-Remy Corp., in the second paper. As any breakdown of this part of the equipment immediately affects the operation of the engine and roadside repairs cannot be made readily by the driver, unfailing performance of the ignition system is imperative, and it is necessary also that the performance at top speed shall be satisfactory without sacrifice of long life. For these reasons the system has undergone refinement as engines have been made more efficient. The present generator and storage-battery system is identical with that first used on the 1912 Cadillac when the electric engine-starter was adopted, except that the units have been improved with the increasing requirements of high-compression, high-speed engines.

Some of the difficulties that have had to be overcome are the effects of engine torsional vibrations on the distributor, the need for an automatic mechanism to advance the time of ignition with respect to engine-piston position, uneven ignition in different cylinders arising from non-homogeneous mixture around the spark-plugs, effects of temperature in excess of 200 deg. fahr. on the material of coil tops and similar parts, the higher secondary-current voltage required to jump the spark-gap at higher compression and higher temperature, and the problems in circuit-breaker cam and lever design imposed by high engine-speeds.

Various types of distributor with four, six and eight-lobe cams, single

Members Who Broadcast at the Friday Morning Engine Session

(Left to Right) L. C. Lichty, of Yale University, Who Discussed the Economic Situation with Regard to Antiknock Fuels; O. C. Berry, of the Borg-Warner Corp., Who Presided; J. T. Fitzsimmons, of the Delco-Remy Corp., Who Discussed Ignition Requirements for High-Compression Engines; and F. C. Mock, of the Stromberg Motor Devices Co., Who Discussed Dual Carbureters and Intake Manifolds

and dual coil, and single and double distributor levers were shown in lantern slides. An interesting series of slides consisted of oscillograph records of the action of the primary and the secondary circuits at engine speeds of 1750 and 3500 r.p.m.

The latter part of Mr. Fitzsimmons' paper was devoted to a discussion of ignition coils and the advantage of high inductance at slow speeds. In conclusion the speaker stated his belief that a device to automatically advance the time of ignition with full opening of the throttle has a certain field. Ignition can be made to meet still higher engine-speeds, according to the speaker, but whether this will be accomplished by increasing the primary voltage by the use of better contact-material, by lower-inductance coils with special engine-starting devices, or by a new and more complicated electrical circuit only time can tell.

Starting Condition Needs Attention

Starting and low-speed operation are the conditions that are most serious today, asserted P. J. Lent, of the Chrysler Corp., in commenting on Mr. Fitzsimmons' paper. He did not offer any suggestion as to how these can be improved, but said it is a problem for the ignition men to work out. Everything in ignition hinges on the contact points, he said, and he has had indications recently that a great deal of progress can be made in the matter of contact. If anyone knows of a better contact material, he thinks he can induce his company to pay the price for it. But Mr. Fitzsimmons replied that he knows of no better material than the pure tungsten his company is using. The whole electrical circuit might be revised and many more parts put into it, making it cost perhaps four or five times as much as at present. About 75 per cent of the so-called contact trouble is not contact trouble at all, and the appearance of the contacts is no criterion of their electrical efficiency; sometimes the contacts that look the worst are the best. His company is searching for a better material, however, but thinks this is a problem for the metallurgist. If contacts are run on a bench test nothing can be shown to be wrong with them, but when they are put in a car and run on the road, something happens. Mr. Kent agreed with this, but thought that something interferes with getting sufficient current of the required voltage and that some development may be made along this line. He maintained that the ignition-apparatus manufacturer should go into the metallurgical aspect.

Dual Carburetion and Manifolding

Eight-cylinder engines have brought the subject of dual carburetion into special prominence, according to F. C. Mock, of the Stromberg Motor Devices Co., who delivered his paper on this subject and illustrated his address with a series of slides. As compared with a single carbureter, the dual carbureter seems, he said, to contribute a definite gain in power to the eight-cylinder engine in the middle speed-range, from 1400 to 2800 r.p.m., and sometimes a considerable gain at high speed, but no particular gain in fuel economy. Nearly all drivers also feel that there is better response to the throttle and a freer pulling at full load, which Mr. Mock suggested may be the result of more even and more positively controlled mixture distribution.

The gain in power seems to result from the absence of overlapping and interference of the suction-strokes, and also from the use of larger manifold passages. With dual manifolding, however, the mass and consequently the heat capacity of the manifold are high in relation to piston displacement, which results in an unusual lag of the mixture temperature while the inlet and exhaust manifolds are warming up and cooling down. Temperature of the hot-spot wall and transference of the heat from the hot-spot to the mixture, for any given engine-load and speed, vary according to the temperature of the air and fuel entering the carbureter mixing-chamber, said Mr. Mock. And, for any given exhaust flow to the hot-spot, the temperature of the mixture and the amount of accelerating charge needed will vary, in opposite directions, with the temperature under the engine hood. For these reasons, controls of the hot-spot and the accelerating charge should be provided or else the carbureter should be insulated against the full range of temperature change that occurs under the hood.

Although the dual carbureter has been blamed for inability of the engine to idle smoothly and for poor fuel-economy at light load, substitution of a single carbureter on the same engine showed no improvement in either respect, according to the speaker, and the fact seems to be that no research has been made on these phases of engine operation. The question of smooth idling seldom is taken into consideration in the design of an engine.

Carburetion problems are relatively simple with the dual system; low velocities may be used and, except at light loads, the mixture is nearly uniform. A difference in the length and the volumetric capacity of the two manifold members causes some variation between the suction and the airflow of the two barrels of the carbureter, but this is not important. Diagrams were shown of manifold designs, with the recommendation that the length from the carbureter be short and the two barrels as nearly as possible of the same length. An explanation was made of the effect of pulsation in the inlet manifold on smooth and efficient operation of the engine. At some speeds there is a loss of power because some cylinders get an insufficient charge, whereas at other speeds a ramming effect seems to crowd in an extra charge and a gain in power results.

Dual carbureters have not successfully replaced single carbureters on six-cylinder engines, because of blowback of fuel spray and air charge from the carbureter inlet, but it seems possible, said Mr. Mock, that a slight change in valve-timing would prevent this and make it possible for the dual carbureter to show a gain in engine power similar to that achieved on the eight-cylinder engine.

Several Phases Discussed

Concluding discussion at the session bore upon both ignition and carburetion. O. C. Rhode, of the Champion Spark Plug Co., referring to blame sometimes placed upon the spark-plugs, said that more attention should be paid to exact setting of the spark-gap; to location of the plugs with respect to the valves and piston and to their projection through the combustion-chamber; to selection of the proper type of plugs for normal service rather than for maximum performance in the dynamometer room; and to making some allowance in the performance characteristics of the spark-plugs during the running-in period of the first 500 miles of driving.

Claude S. Kegerreis, of the Tillotson Mfg. Co., pronounced Mr. Mock's paper the most outstanding carburetion paper the Society has had in years, and said the work of his company checked Mr. Mock's observations on the eight-cylinder engine and mainly also on the six-cylinder engine. In air-cleaner development work it has been found that a considerable spiraling effect of the air entering the carbureter produced bad results; consequently, great pains were taken in the design of the cleaner to straighten out the airflow, and in block tests it has been found that this gives a slight supercharging effect at high torque instead of loss of power. When asked several times in recent months to recommend inlet-manifold temperatures, he has advised 120 to 155 deg. fahr., which is not far from Mr. Mock's recommendation of 160 deg.

J. B. Macauley, of the Chrysler Corp., asked if any ignition men had ever made oscillograms on a firing engine to determine the requirements as to mixture or spark-gap for good ignition. In response, Mr. Fitzsimmons stated that he had made no such tests in recent years but incomplete tests some years ago indicated that, when the carbureter was set to give the maximum torque, the least spark was required to fire the mixture and that, on

enriching or leaning the mixture, more spark was required to jump the gap.

F. G. Shoemaker, of the H. H. Franklin Mfg. Co., made a plea for someone to do some real work on study of actual pressures in inlet manifolds and find out accurately what goes on in the manifold and cylinder.

Factors in Engine Performance

Humidity, Engine Torque, Bore-and-Stroke Ratios, and Fuel Economy Treated

AN automobile engine always will be an object of consuming interest, not only to the men who design and build them but also to the public, in the opinion of L. P. Kalb, of the Continental Motors Corp., who was chairman of the Engine Session held Friday afternoon, Jan. 18. He said also that automotive engineers realize the imperfections of the engine, highly developed though it is, and that the stage of superficial betterment has been passed. From now on improvement must result from dealing with fundamentals such as were dealt with in the papers presented at this session, the first being entitled, Effect of Humidity on Engine Performance. This paper was by A. W. Gardiner, of the General Motors Corp. Research Laboratories, and is printed in full in this issue, beginning on p. 155.

Test-Correction for Moisture

N. S. Diamant, of the Chrysler Corp., remarked that the important feature of Mr. Gardiner's paper is that the author has shown how a correction for moisture can be made. He said that engineers may or may not consider it necessary to make a correction for moisture effect, but the paper presents something definite and the decision whether corrections should be made rests with the individual. M. M. Roensch, also of the Chrysler Corp., commenting on a remark by Mr. Diamant to the effect that it was not necessary to correct all engine tests for humidity but that, when making a series of tests for the accurate determination of power, it is necessary to correct for humidity, stated that, on tests he had conducted, if no correction for humidity was made there was a 3 per cent error; but that, taking humidity into consideration, the results as to power measurement will be the same in succeeding tests.

Bois P. Sergayeff, of the General Motors Corp., advanced the theory that the presence of tiny particles of water in the fuel mixture must produce lower and more effective maximum pressure. At the same time, he said, the area of the indicator diagram representing useful work will not be less and may be greater; that is, a higher mean effective pressure is generated which gives greater engine power. He thinks that this explains the increase in engine power that is noticeable when driving in foggy weather.

H. A. Huebotter, of the Butler Mfg. Co., stated that he began the practice of correcting engine-power data on the basis of dry-air pressure rather than barometric pressure several years ago, and has suggested it to research engineers who found difficulty in obtaining consistent engine-performance from day to day when standardized by the present method advocated by the Society. He said also that the aqueous-vapor pressure in the atmosphere often amounts to as much as 3 per cent of the total barometric pressure in summer. He, therefore, recommended that the Society's Committee on Engine Standards consider Mr. Gardiner's method of correcting for atmospheric pressure with a view to adopting it as an S.A.E. Standard because, in his opinion, Mr. Gardiner's data furnish ample justification for adopting his correction factors officially. A further reason stated was that Fig. 2 of Mr. Gardiner's paper shows that the observed indicated-torque lies below the theoretical engine-torque when the latter is based only upon the variation in the dry-air pressure. Mr. Huebotter said that this apparent discrepancy is consistent thermodynamically, and proves that Mr. Gardiner's laboratory data are accurate to a high degree.

Engine-Torque Analysis

In presenting his paper on Engine Torque, Mr. Huebotter referred to two methods of investigating engine torque, the analytical method[1], by himself, and the graphical method[2], by Prof. M. V. Davidson. The graphical analysis is familiar to the majority of engine designers. Its most commendable feature, which makes it valuable for elementary instructional purposes, is that it visualizes the addition of fluid and inertia forces in each cylinder and the composition of the resulting torques for all the cylinders. When the purpose of the analysis is to determine the engine torque rather than to teach the subject, however, the mathematical treatment deserves recognition by virtue of its greater accuracy, speed, flexibility, and scope.

Without attempting to discuss the subject exhaustively, several applications of the analytical method were presented. The mathematical expressions for the magnitude of the crankshaft torque due to fluid and kinetic forces are written in the form of a Fourier series. The composition of these values to give the total instant torque were explained and the results illustrated graphically. The effect of variables in engine design and operation was analyzed and presented quantitatively by means of curves.

Among the factors to which this analysis was applied by Mr. Huebotter were the following: cyclic speed-regulation, cylinder multiplication, variable load, variable speed, acceleration at no load, offset cylinders, variable compression-ratio, delayed ignition, speed for smoothest performance, crankshaft torsional vibration, ignition failure, the Otto cycle, the Diesel cycle, and radial engines. Special attention was called to the flexibility of the analytical method of engine-torque investigation and to the scope of the problems that can be solved by its use.

In the course of the discussion, M. J. Zucrow, of Purdue University, explained that Mr. Huebotter's analysis hinges on two concepts. One is that any periodic curve can be represented by a series of sine and cosine terms called a Fourier series. By doing this in connection with the fluid pressures and the inertia forces, they can be combined and the equations can be studied for purposes of design. Several ratios of the length of rod to crank radius should be calculated and curves plotted for several values. Then other ratios that may be under consideration in connection with experimental engines can be interpreted. One analysis covers all the conditions, and the remainder of the work is merely to write down the equations for torque. By inspecting the equations, it is evident which harmonics come into play and which do not.

Large-Bore Engines Advocated

In his paper on Large-Bore versus Small-Bore Engines, Alex Taub, of the Chevrolet Motor Co., made comparisons of the respective characteristics of the large-bore short-stroke engine and the small-bore long-stroke engine in connection with his argument that the former best fulfils the requirement that an engine must be a good product that is easily produced. He chose the L-head type of engine for purposes of illustration, since this type is within the scope of the experience of all automotive engineers.

Mr. Taub said in part that when consideration is being given the specifications of a new engine, the first problem to be met is the determination of length. Usually a certain length is set arbitrarily, but this circumscribes the

[1] See S.A.E. Journal, July, 1928, p. 107.

[2] See S.A.E. Journal, July, 1928, p. 110; see also S.A.E. Journal, September, 1927, p. 315.

designer at the outset and, for some unaccountable reason, a new project is thus compromised **rather than** to change the preconceived idea of what the length of wheelbase must be. But there is abundant evidence in the industry as to what happens when a designer starts to "crowd," and the author asserted that, if engines are to represent something more than so much cast iron equipped with plumbing, sufficient space for the engine must be allowed. He then discussed how large the cylinder bore should be.

After considering the subjects of valve cooling and engine stability, cylinder-block construction was analyzed and a method of construction described whereby the block is cast on end. By this method each half of the block is a separate casting, but a simple liquid assembly of the two is made by fastening together the two molds in their respective flasks before pouring.

The advantages and disadvantages of the two types of crankshaft were discussed and the proper distribution of crankshaft material to secure correct balancing was stated. The effects of counterweights were then analyzed and, in conclusion, Mr. Taub said that the large-bore design offers a good engine that has a maximum performance over the longest period, **and that it can be** produced more easily and at lower cost. It has also better cylinder-blocks, better crankshafts for less cost, and presents a greater opportunity for further development than does the small-bore long-stroke engine.

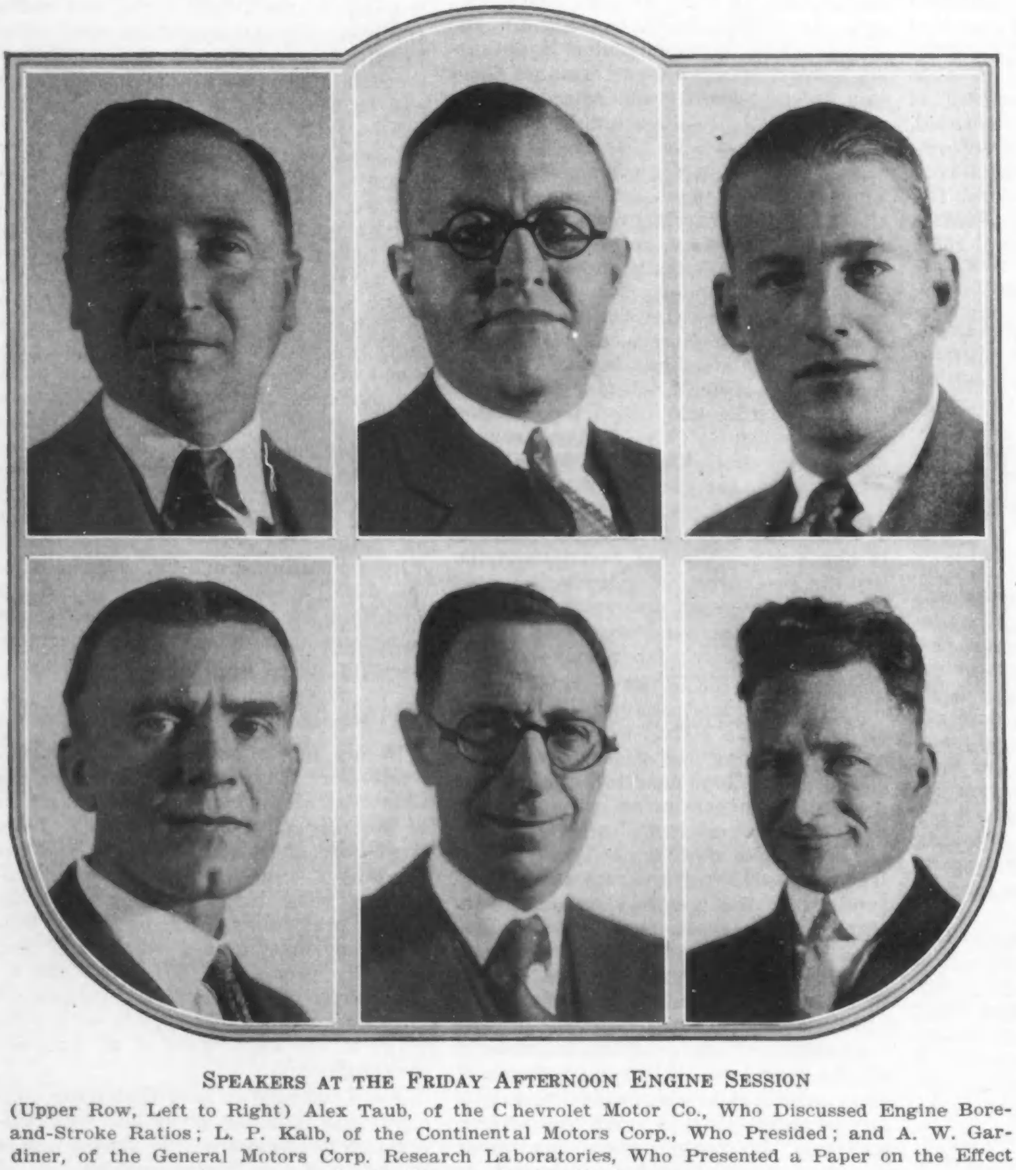
Considerations as to Cooling

Discussing Mr. Taub's paper, L. P. Saunders, of the Harrison Radiator Corp., said that, assuming the water-jacket on both types of engine as extending to a position representing the top of the piston when at the bottom of its stroke, it will be found that the number of square inches of water-jacketed surface per cylinder bore for the long stroke-engine represents 50.3 sq. in. as compared with 44.1 sq. in. for the short-stroke engine. Therefore, with a given volume of water per horsepower per minute in circulation through the jackets, the water is changed more times per minute in the large-bore than in the small-bore engine. He said also that one of the essentials of present-day engines is to provide sufficient water around the valves. The performance of an engine may depend on this feature of the design, and the large-bore type assures that the jacket design will be satisfactory.

Comparing the cooling of the large-bore with that of the small-bore engine, Mr. Saunders stated that tests were made with a car having a large-bore engine the radiator of which contained 2 sq. ft. less area than that of another car equipped with a small-bore engine. At a speed of 50 m.p.h., the car with the large-bore engine would operate in an air temperature approximately 15 deg. fahr. higher without boiling than would the car equipped with the small-bore engine.

In the opinion of A. J. Meyer, of the Continental Motors Corp., it is possible to build a good substantial engine having high power-output and durability with either a long or a short stroke. He feels that there are good examples of both types on the market. It is not necessary to cast cylinders and valve pockets together when dealing with a long-stroke engine. The valve size can be decreased or the engine lengthened until the result is a design for a good engine having reasonable bearing loads. Mr. Meyer showed charts embodying the data from tests of a series of engines all of the same type but covering a wide range of displacement, in which both a long-stroke and a short-stroke design was chosen for each size of engine. In conclusion, he said that the man who determines the engine bore and the length of stroke and who insists on compactness is responsible for the quality of the entire engine.

Dr. H. C. Dickinson mentioned as a rather startling



Speakers at the Friday Afternoon Engine Session

(Upper Row, Left to Right) Alex Taub, of the Chevrolet Motor Co., Who Discussed Engine Bore-and-Stroke Ratios; L. P. Kalb, of the Continental Motors Corp., Who Presided; and A. W. Gardiner, of the General Motors Corp. Research Laboratories, Who Presented a Paper on the Effect of Humidity on Engine Performance

(Lower Row, Left to Right) A. J. Meyer, of the Continental Motors Corp., Who Discussed Mr. Taub's Paper: N. S. Diamant, of Chrysler Motors, Who Discussed Mr. Gardiner's Paper; and H. A. Huebotter, Who Discussed Engine Torque

fact that about 50 to 60 per cent of all the fuel burned in an automobile engine is burned merely to shear an oil-film; that is, to turn the engine over. In other words, decreasing the bore-stroke ratio has a very important effect in reducing the total amount of oil-film that must be sheared while the engine is operating.

THE QUEST FOR POWER

According to H. M. Jacklin, of Purdue University, designers of internal-combustion engines have always been on a quest for power. The two latest turns that this quest has taken have resulted in the use of larger cylinder-reamers and in increased compression. Emphasis has been placed on acceleration and top speed, both requiring a high power-development at any given engine-speed, and his thought was to present some material that may help considerably in increasing the over-all thermal efficiency at partial loads, the preponderant condition under which cars are operated. He described a carefully performed recent investigation and presented the data collected.

Indicator diagrams were obtained from a four-cycle 3 x 4-in. single-cylinder engine, and Professor Jacklin showed a general view of the engine set-up, including the dynamometer and high-speed indicator, and also a series of typical diagrams as obtained in the tests. These diagrams showed clearly that better combustion resulted at all partial-throttle settings, the combustion and expansion lines being smoother with constant - compression operation than when constant-clearance operation was used. He then made comparisons of performance, interpreting the curves presented, and discussed the application of the data to car performance, although the details have not yet been worked out. He stated that the miles-per-gallon curves show the calculated values under ordinary engine-operating conditions and those with constant compression, indicating a possible gain of 50 per cent in mileage of the latter over the former. From the data presented in the test results, he said that it seems possible that a 20 to 30-per cent gain would be obtained if the spark were advanced when lower loads are required.

Production Developments

Chromium-Plating, Improved Steel, Grinding-Wheel Standardization, and High-Velocity Penetration

THIS session, presided over by John Younger, was constituted of papers on four interesting topics, a demonstration of the Temple high-velocity penetrating devices, and a 30-min. motion picture presented by the Carborundum Co., illustrating the discovery of hard abrasive material by Dr. Acheson, the development of the abrasive industry and the many high-production applications of the present-day grinding wheels and machines.

CHROMIUM-PLATING DISCUSSED

M. F. Macauley presented a paper prepared by him and W. M. Phillips on Recent Developments in Chromium-Plating that summarized the experience in developing this type of plating and gave many hints of importance that must be recognized in using it. The paper indicated that the use of chromium-plating has become almost universal for decorative purposes on automobiles, while in production engineering it is being used on tools and gages because of its effective resistance to wear, extending the life of gages to about three times that of ordinary tool-steel.

In the discussion, J. T. Caldwell described a method of testing by blue light for imperfections in chromium-plating, being based on the fact that chromium reflects more of the blue rays while nickel reflects more of the yellow. Discussion regarding the relative cost of chromium-plating and copper-nickel plating indicated that the former is usually greater unless the nickel-buffing operation can be omitted, in which case the costs seem to more nearly balance. One statement was to the effect that in the usual commercial-shop the chromium-plating would cost 15 to 20 per cent more.

An interesting point brought out in the discussion was that chromium can be successfully used on zinc-base die-castings without the usual copper under-

SPEAKERS AT THE FINAL SESSION AT WHICH PRODUCTION PROBLEMS WERE DISCUSSED

Frank E. Shepard (Left), Who, with Robert Temple (Right), Demonstrated the Temple High-Velocity Penetrating Devices; T. McLean Jasper (Second from Left), Who Discussed Specifications for Automotive Steels; John Younger (Center), Who Presided; and B. H. Work (Second from Right), of the Carborundum Co., Who Discussed Recent Developments in Production Grinding

plate, the copper being omitted because of its tendency to soak into the zinc. Discussion of anodes indicated that thick ones are usually more satisfactory than thin ones. It was also stated that chromium-plating on steels that are to be subjected to fairly high temperatures is not always satisfactory because of the difference in the expansion coefficient of chromium and steel. Mr. Phillips indicated, however, that in some tests where the chromium-plating was approximately 1/20 of 0.001-in. thick, it has under certain conditions withstood 450 deg. Fahr. without checking. Mr. Jasper mentioned a case in which about 900 deg. had been reached.

Better Frames from Purer Steel

The paper by T. McLean Jasper on Steels for the Automotive Industry dealt with the progress being made in reducing impurities in steel, with the result that better design and performance of automobile frames produced more economically are made possible. He also indicated that large economic losses due to corrosion of steel in use can be avoided by reducing the quantities of impurities in it. Allusion was made to the development of general steel specifications by National bodies such as the American Society for Testing Materials, the American Society for Steel Treaters, and the S. A. E., but stated that it is usually the progressive industry that is in the van of improvement. The speaker also pointed out that at present the physical properties of steel do not provide a complete measure of its workability, and said that his company is now developing methods for more completely pre-determining the workability characteristics of a given steel.

The paper emphasized the importance of careful consideration being given in the design of automobile frames to keeping the high stresses set up in fabricating, particularly along edges, as low as possible by using larger radii at the kick-up and other places where the metal undergoes severe strain in the forming operations. The present rate of frame production in the author's plant was given as about one frame every ten seconds, but Mr. Jasper stated that, with the developments in processes and materials that are being made, it is expected that this rate will be increased soon to one frame in every seven seconds. He concluded with a strong plea for closer cooperation between the car engineer and the frame builder to bring about the design, manufacture and use of better automobile frames.

Grinding-Wheel Standardization

The paper read by B. H. Work on Recent Developments in Production Grinding referred to the efforts that are being made by the grinding-wheel manufacturers, through the Division of Simplified Practice of the Department of Commerce, to effect simplification of the number of sizes and shapes of abrasive wheels. The author indicated that grinding-wheels can be classed with modern cutting-tools but differ in that they must be self-sharpening. He pointed out the many factors that must be taken into consideration in the building and specifying of grinding-wheels as well as the combinations of factors that must be considered in selecting wheels for given operations.

The paper then dealt with the problems of the wheel manufacturer as involving three factors: the abrasive, the bonding material, and the process of manufacture, which together create the further variable, wheel structure. Mr. Work stated that grinding-wheels are usually made of either fused aluminum oxide or carbide of silicon. He indicated that production of grinding-wheels is not so much a question of technical details in manufacture as it is the correlation of an infinite number of details the application of which depend largely upon experience.

In reviewing the variable factors occurring in the grinding-wheel user's plant, the author indicated that the user's problem is largely one of standardizing equipment and operating conditions so that one type of grit can be used efficiently on a greater variety of operations, but that present practice tends toward a still greater diversity of wheels, thus offsetting effective simplification and standardization.

In conclusion, he stated that, in the light of what has been accomplished recently in the work of standardization, a thorough understanding of mutual problems between the wheel users and the wheel manufacturers, together with cooperative effort, will result in the effective solution of this great problem in the industry today.

Shooting Metal for Density

F. E. Shepard presented a paper entitled Temple High-Velocity Penetrating Devices, in which was described the construction and operation of the gun in accomplishing penetration at controlled high velocity of projectile. The paper indicated that undoubtedly many applications of this process will be developed as, for example, making die-castings and forgings of perfectly formed parts having greater density of material, elastic limit and tensile strength. He also indicated that many uses can be made of it in submarine operations for repairing and salvaging. One interesting possibility described is the exploring of geological formations to locate oil fields.

The author stated that in the early development of this process tempered carbon-steel pins were used but that these crystallized in the penetrating operation, and that the pins now are made of a molybdenum-alloy steel, molybdenum effectively preventing the crystallization.

Robert Temple then demonstrated the device by penetrating a number of steel plates of about 5/8-in. thickness with pins of about 3/8-in. diameter. This created marked interest and led to many questions, such as the tightness with which the pins are held in the plates, whether corrosion occurs between the pin and the plate, whether the metal in the plates flows into depressions in the pin, and whether a physical change occurs in the plate around the point of penetration. Mr. Temple replied that apparently no corrosion occurs, that the pin is gripped so tightly by the metal flowing around it that about 7 tons' pressure would be required to push it out, that the joint around the pin is therefore entirely gas tight, and that no physical or chemical change occurs in the steel of the plate.

Meetings of Research Committee and Subcommittees

Despite an already crowded program, members of the Research Committee and its Subcommittees found time between sessions of the Annual Meeting for a whole schedule of Committee meetings.

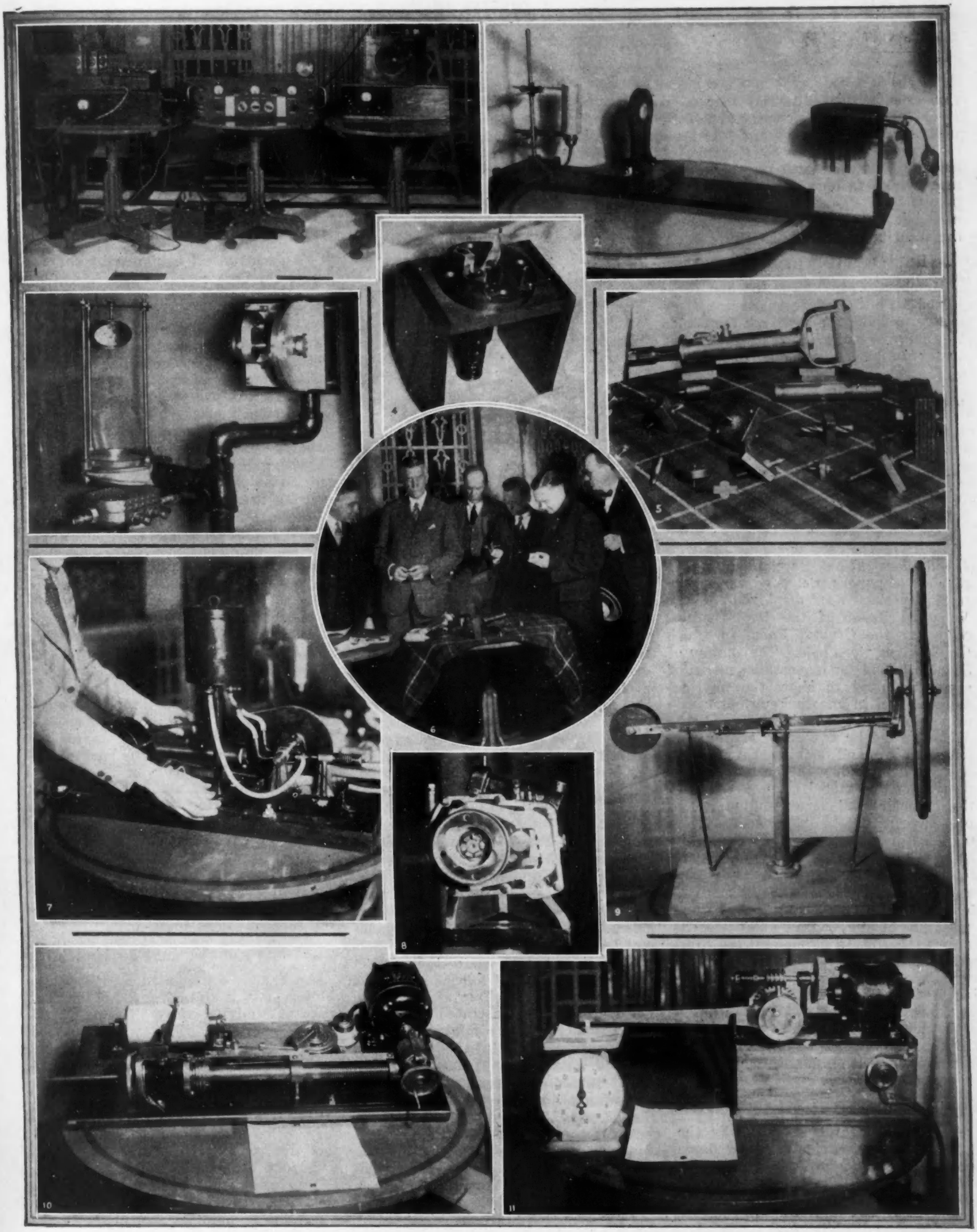
The Front-Wheel-Alignment Subcommittee met for a luncheon meeting on Wednesday to hear a report from Chairman J. M. Nickelsen on the progress of work in securing wheel-alignment data that is being directed by O. T. Kreusser at the General Motors Proving Ground. The report was approved by the Committee and presented at the Chassis Session on Thursday.

The Highways Subcommittee held a luncheon meeting to consider progress reports on the work under way at the Bureau of Public Roads on motortruck impact tests, with the cooperation of the Bureau of Standards on instrumentation. Considerable time was spent in discussing the problems which the future program will entail.

H. H. Allen's report to the Headlight Subcommittee on the last six months' work on the headlight project at the Bureau of Standards, together with the comments received from observers at the headlight demonstration at Milford, Mich., on Oct. 17, brought about a lively discussion at the headlight dinner-meeting that continued on through the evening. Some very definite plans for the future line of procedure were mapped out and tentative arrangements were made for another meeting at an early date.

Riding-Qualities Research

Prof. H. M. Jacklin, who is directing the riding-qualities research at Purdue University, reported on this phase of the riding-qualities project. The work



APPARATUS AND DEVICES EXHIBITED AT THE ANNUAL MEETING

(1) Noise-Detecting and Pitch-Determining Apparatus Exhibited by F. A. Firestone. (2) Bureau of Standards Apparatus Used To Show the Physical State of Fuel in Gasoline Engines. (3) Apparatus Devised at the Bureau of Standards for Studying Flame Propagation. (4) Indicator for Studying Valve Lift and Valve-Spring Vibration, Exhibited and Described by Ferdinand Jehle and W. R. Spiller. (5) and (6) Temple High-Velocity Penetration Devices Shown by Robert Temple. (7) Bureau of Standards Apparatus for Indicating Whether a Journal Bearing Is Completely Lubricated. (8) Noback Automatic Reverse-Brake. (9) Gyrostatic Device Exhibited by H. A. Huebotter for Demonstrating Principles Relating to Front-Wheel Shimmy. (10) Shiftometer for Measuring the Relative Gearshifting Resistance of Transmission Lubricants, shown by the Vacuum Oil Co. (11) Dragometer Used by the Vacuum Oil Co. for Measuring the Relative Starting Resistance of Engine Oils

since the last meeting has chiefly been concerned with the development of instrumentation. The other part of the program, proposed by Dr. F. A. Moss, of George Washington University, for devising and standardizing methods of measuring fatigue, which was approved by the Committee at a previous meeting, will be undertaken subject to the securing of funds.

RESEARCH DINNER-MEETING

Members of the Subcommittees joined with those of the parent Committee to make the Research Dinner on Thursday a very interesting meeting that brought out a number of valuable suggestions for the future work on the various projects. Reports were heard from T. A. Boyd, who represents the Society on the Joint Committee on Atmospheric Pollution by Automobile Exhaust-Gases, and from E. W. Stewart, who is one of three Society representatives on the A.S.M.E. Special Research Committee on Mechanical Springs, as well as from the Subcommittee chairmen.

To enable everyone to attend the meeting at the Chrysler laboratory that evening, it was necessary to bring the meeting to an early close, but a very satisfactory amount of business was covered in surprisingly short order.

Demonstration Devices Displayed

Interesting Research Apparatus Used at the Annual Meeting for Elucidating Papers

APPARATUS used in connection with demonstrations accompanying a number of papers presented at the Annual Meeting was displayed in the Venetian Room of the Book-Cadillac adjoining the Crystal Room in which the Sessions were held. The Bureau of Standards had for inspection a model of apparatus used to show the physical state of fuel in gasoline engines. The principle upon which this is based was demonstrated by squeezing the bulb of an atomizer and looking through an observation window in the side of the portion of the model corresponding to the cylinder-head of an engine. The presence of liquid particles is thus made evident by the light they scatter. In a test made at the Bureau, it was found that, in the particular engine used, fog was present in the inlet manifold at all times during the normal operation of the engine. Particles as large as 1 mm. in diameter were present under many conditions of carbureter and throttle settings. In starting, it was observed that if the throttle was opened the fog was weak, but a great many particles were present. If the throttle was partly closed, the fog increased and the particles could no longer be seen.

FOR STUDYING FLAME PROPAGATION

Another apparatus exhibited by the Bureau was devised for studying flame propagation in an internal-combustion-engine cylinder. The purpose of this device is to make possible the observation of the flame in an engine cylinder as it spreads from the spark-plug throughout the combustion chamber. Thirty-one quartz-glass windows are symmetrically distributed over the combustion space in a special cylinder-head fitted to a single-cylinder Lockwood-Ash marine engine. Light from the explosion passes through these windows to a large lens mounted just over the head which brings the light to a focus at a stroboscope composed of two rotating discs driven by the engine crankshaft. Holes drilled in the discs permit a momentary view, equal to 4 deg. of crank angle, of the windows at the same point in successive cycles. By making observations at different points in the cycle, the progress of the flame can be charted and the effect of operating conditions and of various fuels can be studied.

BEARING LUBRICATION INDICATOR

Another apparatus for showing whether a journal bearing is completely lubricated was also exhibited by the Bureau of Standards. An indicator lamp on the model lighted up when there was metallic contact between the journal and the bearing. The load, the speed and the position of the oil hole can be adjusted to show their effect upon completeness of lubrication. With this apparatus the effect of change in speed can be demonstrated by reducing the speed to the minimum, using the slide-wire rheostat and adjusting the load by a wing-nut until the lamp is just lighted, then increasing the speed and noting the effect on the lamp. The effect of change in load can be shown by adjusting the speed to a point where the lamp just goes out and then increasing the load and noting the effect on the lamp. To show the effect of change in the oil hole, the speed and load are adjusted until the lamp is out and the bearing is rotated so that the oil hole is on the loaded side, and then the effect on the lamp is noted.

ENGINE FOR KNOCK TESTING

An experimental knock-testing engine of the fixed-compression type, equipped with an interchangeable variable-compression cylinder was another exhibit. This is the engine used by the Cooperative Fuel Research Steering Committee in connection with the work on fuel research, and is described in the department of Automotive Research in this issue, on p. 212.

DRAGOMETER AND SHIFTOMETER

An instrument exhibited by the Vacuum Oil Co.'s research department was the dragometer for measuring the relative starting resistance of engine oils. The sleeve and journal are coated with oil and the apparatus is chilled in a cold room to the desired temperature. The motor is started and the torque observations are made at "breakaway" and while running. The linear speed of the bearing is designed to equal the average rubbing velocities in the average engine at 30 r.p.m., which is selected as the minimum cranking speed for an assured start.

A shiftometer for measuring the relative gearshifting resistance of transmission lubricants was also shown by the Vacuum Oil Co. The spline and the "gear" are coated with oil and the gear is placed on the spline, after which the assembly is chilled in the cold room to the desired temperature with assisting internal brine-circulation in the spline. The spline and gear are then placed in the apparatus with the ram fully withdrawn; next, the ram is advanced until the gear motor just touches the spring collar, the motor is started and the ram driven toward the spring. Resistance to the motion of the oil film between the gear and the spline compresses the spring, the force generated being registered on a card. The rate of travel is 1 in. per sec. A reversing switch prevents over-run, which would damage the instrument. Any number of splines and gearsets can be used to speed up the tests. Springs of different tension can be used.

VALVE-SPRING VIBRATION INDICATOR

An exhibit contributed by the White Motor Co. was an indicator for the purpose of studying valve lift and valve-spring vibration. This was described at the meeting by Ferdinand Jehle and is shown in the paper on Idiosyncrasies of Valve Mechanisms and Their Causes, by Mr. Jehle and W. R. Spiller, beginning on p. 133 in this issue.

In connection with H. A. Huebotter's discussion on front-wheel shimmy, a gyrostat device for demonstrating the principles of front-wheel precession was exhibited. This is described briefly in the news account of the Chassis Session on Thursday afternoon, Jan. 17.

An automatic reverse-brake, described by J. G. Monjar in discussion on Carl D. Peterson's paper on Axle Ratios and Transmission Steps, was another interesting exhibit. This

goes under the trade name of the No-back and is incorporated in this year's Stutz and one or two other cars. It was shown built into a transmission and covered by a glass window through which its operation could be observed as the gears were shifted for the different forward speeds and reverse.

Noise-detection and pitch-determining apparatus whereby noises caused by transmission gears can be measured and the source of the noise located by determining its pitch was exhibited by Floyd A. Firestone, of the University of Michigan, who demonstrated how the apparatus can be adjusted so as to become responsive to notes of a certain pitch when sounded on a piano. Robert Temple showed explosively actuated devices whereby structural-steel parts can be doweled together with metal dowels which penetrate the steel because of the extreme velocity of their projection.

Raymond L. Gruss

INFORMATION has been received that Raymond L. Gruss, president and general manager of the Gruss Air Spring Co. of America, San Francisco, passed away on Oct. 13.

Mr. Gruss had been an Associate Member of the Society since May, 1924. He was born at San Jose, Cal., in 1886, and received his education in the grammar and high schools in Reno, Nev., and the California School of Mechanical Arts. From early youth he was engaged in the designing and construction of mining and milling equipment, and later invented and patented the motor-vehicle air spring that bears his name. He was engaged in the manufacture of these springs during the last 16 years.

Floyd B. Hubbard

FOLLOWING an illness of more than a year, Floyd B. Hubbard passed away at the age of 45 years at his home in Detroit, on Oct. 19, survived by his widow, twin daughters, mother, sister and two brothers. At the time of his death, Mr. Hubbard was associated with the General Motors Corp. Research Laboratories, where he was highly regarded both professionally and personally.

Mr. Hubbard was one of the early design and layout engineers in the automotive field and had devoted most of his working life to this industry from the time of leaving high school and manual-training school. Born at Vermontville, Mich., in October, 1883, he began his career in the automotive industry as layout and design engineer with the Olds Motor Works at Lansing, Mich., where he remained for 2¼ years. Thereafter he was successively connected in similar capacities with the Reliable Dayton Motor Car Co., in Chicago; the Cadillac Motor Car Co., in Detroit; the Woods Electric Vehicle Co. and the Buda Co., in Chicago; the Murray Mfg. Co., of Wausau, Wis., for which he was engaged in layout and detail work on sawmill plants and machinery; the Goodman Mfg. Co., of Chicago, on electric mine-locomotives; the Kneeland Gas Engine Co., of Lansing, Mich.; the Western Electric Co., of Chicago, the Wilson Hind Co., of Wausau, Wis., on advertising specialties; and the Buda Co., of Harvey, Ill.

It was while employed as designer of four and of six-cylinder engines for the Buda Co., in 1913, that Mr. Hubbard was elected to Member Grade in the Society.

Arthur E. Parsons

WITH profound sorrow the sudden death of Arthur E. Parsons on Oct. 31 was announced by the Brown-Lipe Gear Co., of which Mr. Parsons was treasurer and general manager. He passed away of heart trouble on the train while en route from Cleveland to Syracuse.

Born at Syracuse, N. Y., in 1867, and graduated from the high school in that city, Mr. Parsons was for three years engaged in drafting and mechanical designing and subsequently was for 20 years a patent lawyer, devoting his time constantly to studying and investigating automobile, electrical and other mechanical and technical subjects. He was admitted to practice as an attorney before the Supreme Court of the United States.

As legal counsel in patent matters to the Brown-Lipe Gear Co., Mr. Parsons had close association with the executives of the company, and in 1918 became its secretary and general manager. Four years later he was elected treasurer and general manager.

Mr. Parsons was elected to Associate membership in the Society in 1917, and was a member of the Metropolitan Section during the years 1925 and 1926.

William Stone Stockton

LEAKAGE of the heart valve resulted in the premature passing of William Stone Stockton, assistant chassis engineer of the Willys-Overland Co., on Oct. 30, at the age of 34 years.

Mr. Stockton was elected to Junior-grade membership in the Society in June, 1917, and was transferred to Member grade in May, 1924. He was born at Bayonne, N. J., in November, 1894, and was graduated from Cornell University in 1916 with the degree of Mechanical Engineer. From June, 1916, to March, 1917, he served as machinist with the E. Ingraham Co., of Bristol, Conn., and as junior engineer with the New England Westinghouse Co.

At the time of joining the Society in 1917, Mr. Stockton was mechanical draftsman and designer for the New Departure Mfg Co., of Bristol, for which his work was concerned largely with the application of ball-bearings to automotive products. During the years 1920 to 1928 he was intimately associated with chassis design and engineering for the Willys-Overland Co. His immediate superiors and associates regarded Mr. Stockton highly as possessing unquestionable ability and as one of the best automobile engineers with whom they had been associated.

Arthur G. Chestelson

AFTER traveling for some time in an attempt to regain his health, Arthur G. Chestelson, of Webb, Iowa, passed away recently.

Born at Webb, Iowa, in June, 1903, and graduated from the Webb High School in 1922, Mr. Chestelson entered the automotive industry in 1925 as a tracer for the Cadillac Motor Car Co. In April of the same year he took a position with Dodge Brothers, Inc., as detailer, and in August was transferred to Graham Brothers, working as draftsman at Evansville, Ind., and later in Detroit.

In January, 1927, while still serving as layout draftsman for Graham Brothers in Detroit, Mr. Chestelson was elected to Junior-grade membership in the Society.

Roger W. Griswold

ROGER W. GRISWOLD, president of the Vulcan Motor Devices Co., of Philadelphia, and an Associate Member of the Society since January, 1914, passed away suddenly on Oct. 25. No successor to the presidency of the company had been named up to Nov. 20.

Mr. Griswold was born at Taylor's Falls, Minn., in November, 1869, and took a two-years' mining-engineering course at the University of Michigan. His successive commercial connections were as secretary and treasurer of the Welch Folding Bed Co., secretary of the Widdico Furniture Co., and vice-president of the Stickley Brothers Co., all of Grand Rapids, Mich.; vice-president of the C. H. Geist Co., of Philadelphia, and president and general manager of the Vulcan Motor Devices Co., of Philadelphia.

Administrative Committees for 1929

Announced at Council Organization Meeting Jan. 18—Group-Committee Personnel also Named—Memberships Acted Upon at Jan. 10 Meeting

A SESSION of the Council was held in New York City on Jan. 10, those attending being President Wall; First Vice-President Strickland; Past-President Hunt; Second Vice-President H. T. Woolson; Treasurer Whittelsey; and Councilors Wooler, Templin, Whittington and Veal; also E. P. Warner, A. Moyer, and V. W. Kliesrath, who had been nominated to serve on the 1929 Council.

The election of 15 members, 6 grade transfers, 2 reinstatements and 1 reapproval, as well as a change in record of name, on which the Council had acted by mail vote, were confirmed. One hundred and forty-three additional elections to memberships were approved, as well as 11 transfers in grade of membership. The resignations of 63 members were accepted, 31 members were dropped for non-payment of dues, and 3 reinstatements to membership were approved. Five applications were reapproved, as well as 1 change in affiliate-member representation.

At the session of the Council held on Jan. 15 in Detroit the following were present: President Wall; First Vice-President Strickland; Treasurer Whittelsey, and Councilors Veal, Wooler and Whittington. Messrs. O. C. Berry, W. T. Fishleigh and O. A. Parker, nominees for the 1929 Council, also were present.

Organization Meeting of Council

The organization session of the 1929 Council was held in Detroit on Jan. 18, with the following in attendance: President Strickland; Second Vice-Presidents Sawyer, Berry, and Kliesrath; Councilors Fishleigh, Moyer, and Parker.

President Strickland announced the personnel of the 1929 Administrative Committees as follows:

CONSTITUTION COMMITTEE

H. E. Coffin, *Chairman*

J. C. Chase — W. T. Fishleigh

FINANCE COMMITTEE

W. L. Batt, *Chairman*

Joseph Bijur — W. G. Wall
V. W. Kliesrath — C. B. Whittelsey

MEETINGS COMMITTEE

J. A. C. Warner, *Chairman*

F. A. Cornell — L. C. Hill
H. M. Crane — N. G. Shidle
S. R. Dresser — F. M. Zeder

MEMBERSHIP COMMITTEE

E. F. Lowe, *Chairman*

A. K. Brumbaugh — H. A. Hansen
E. Favary — A. M. Jones

Ex-officio: The Chairmen of the Sections Membership Committees.

PUBLICATION COMMITTEE

John Younger, *Chairman*

F. O. Clements — F. Jehle
M. C. Horine — G. W. Lewis

SECTIONS COMMITTEE

V. G. Apple, Dayton, *Chairman*

E. M. Kimball, Buffalo
F. G. Whittington, Chicago
S. L. Bradley, Cleveland
W. T. Fishleigh, Detroit
F. F. Chandler, Indiana
C. L. Drake, Metropolitan
Walter V. Isgrig, Milwaukee
Albert Lodge, New England
H. L. Hirschler, Northern California
C. O. Guernsey, Pennsylvania
Eugene Power, Southern California
C. H. Warrington, Washington
F. K. Glynn, member-at-large
B. J. Lemon, member-at-large
E. W. Templin, member-at-large

The names of the members who will serve this year as Chairman and Vice-Chairman of the Standards Committee and its Divisions were reported. A. J. Scaife will be Chairman, and Arthur Boor and G. L. McCain, Vice-Chairmen, of the Committee. The names of the Division Chairmen and Vice-Chairmen, as well as of those named by the Council for service this year on the various Divisions of the Standards Committee, are listed elsewhere in this issue of THE JOURNAL; also the 1929 lists of members serving on various committees connected with the standards work and other matters, and as representatives of the Society in the activities of other organizations or in work jointly conducted by the Society with other organizations.

H. L. Horning was named as Chairman of the Research Committee for 1929. The personnel of the Research Committee, as well as of the Subcommittees of that Committee, is listed on p. 192 in this issue of THE JOURNAL.

Committees were also named to represent the interests of various groups, as follows: Aeronautical Committee, Motor-Vehicle Committee, Production Committee, and Transportation Committee (formerly called Operation and Maintenance Committee). The personnel of the Production and of the Transportation Committees is given in this issue of THE JOURNAL on page 195. Those asked to serve on the Aeronautical and the Motor-Vehicle Committees are as follows:

AERONAUTICAL COMMITTEE

E. S. Land, *Chairman*

E. E. Aldrin — G. C. Loening
Karl Arnstein — C. J. McCarthy
C. H. Colvin — W. P. MacCracken, Jr.
H. M. Crane — A. L. Martinek
F. Trubee Davison — C. N. Monteith
G. W. DeBell — W. C. Naylor
C. L. Egtvedt — Arthur Nutt
S. M. Fairchild — H. F. Pitcairn
L. D. Gardner — G. A. Rentschler, Jr.
W. E. Gillmore — L. D. Seymour
J. C. Hunsaker — Mac Short
E. T. Jones — Frank Tichenor
B. G. Leighton — Chance M. Vought
G. W. Lewis — E. P. Warner
J. E. Whitbeck

MOTOR-VEHICLE COMMITTEE

George L. McCain, *Chairman*

J. M. Crawford — W. C. Keys
W. J. Davidson — F. F. Kishline
W. N. Davis — F. Sergardi
W. T. Fishleigh — L. S. Sheldrick
W. R. Griswold — Alex Taub
H. L. Horning — P. L. Tenney
L. P. Kalb — F. E. Watts
A. M. Wolf

To Form Student-Branch Committee

A number of matters of interest to S.A.E. Student Branches were discussed at both of the Council meetings held in Detroit, the purpose being to assist and foster Student activities adequately in the interest of the students themselves and of the industry. A Student-Branch Committee of the Society is to be organized, and prizes are to be given for undergraduate-student papers of merit. Detail announcement of these matters will be made in due course.

The Council also defined a policy as to recognizing entertainment expense at meetings of Sections of the Society. In case of local financing of such expense being impossible, appropriation is to be made from the treasury of the Society.

Charles L. Lawrance, Henry M. Crane and George W. Lewis were named as a Board of Judges of Award of the Manly memorial medal.

Automotive Features of 1929

Metropolitan Section Stages Its Fourth Annual Automobile-Show Dinner and New-Car Review

THE Fourth Annual Automobile-Show Dinner of the Metropolitan Section, held at the Hotel Commodore, New York City, Jan. 7, was a gala occasion. In his opening remarks, Chairman S. R. Dresser reviewed briefly the constructive work already accomplished by the Metropolitan Section and said that, during Show week, it has been the practice for the last two years to invite representative chief engineers to give talks on the engineering improvements in automobiles. This custom was followed again at the technical session held after the dinner, approximately 500 members and guests being present.

H. L. Horning, of the Waukesha Motor Co., was scheduled to summarize the developments in the automobile engines of 1929. In his absence on account of illness, his manuscript was read by J. B. Fisher, of the same company. Sir Herbert Austin, director of the Society of Motor Manufacturers and Traders, Ltd., of England, spoke briefly on the development of the automobile in Europe. The 1929 chassis were commented upon by Austin M. Wolf, consulting engineer; and the 1929 bodies were similarly analyzed by Francis D. Willoughby, of the Willoughby Co. An analysis of what 500 users think of their cars was presented by Past-President J. H. Hunt.

Novel features of the occasion included a package of half a dozen or more souvenirs of special interest to automotive engineers, which was presented to each person who entered the room, these having been supplied by various automobile and other companies; a jazz band, assisted by three specialty dancers and singers, who called themselves Three Bad Habits; and last, but certainly by no means least, the Happiness Boys, famous as radio entertainers, who crowned themselves with further glory by putting over some real honest-to-goodness automotive humor in dialogue, patter-talk and songs.

Motor-Car Engines of 1929

Summarizing the mechanical improvements in the motor-cars for 1929, Mr. Horning said that, with few exceptions, they have greater acceleration, smoother operation, and higher speeds compared with former models, and probably about the same operating economy because the greater acceleration will offset the better specific economy of the engines. Acceleration demands have necessitated research regarding valve timing, manifolds, gas passages, and mechanically operated accelerating wells of the squirt-gun type in carbureters, the last feature being the outstanding change in the carbureters and one that is found on a wide range of cars. The demand for smoothness of engine operation has caused an intensive study of engine balancing and mounting, and this has resulted in balanced crankshafts, flywheels and clutches and in closer matching of the weights of pistons and connecting-rods. The effects of secondary out-of-balance, combustion shocks and torque reactions of high-output engines have been reduced by mounting the engine on springs or on rubber.

Two schools of thought exist regarding engine speeds, said Mr. Horning. One advocates medium speed so that the engine speed will be relatively low for any specific high speed of the car; the other attempts to produce engines which can withstand extremely high speed indefinitely. Both schools are producing important improvements in the design of American cars.

Narrower piston-rings and more of them are the rule for 1929. Some cars have two compression and two oil-scraper rings; no doubt a superabundance of oil is thrown on the walls and then scraped off. Scraper rings utilizing the blow-by are used almost universally.

Lapping instead of grinding cylinders has become almost universal production practice. The "reamer" has been used this year with the usual regularity, and it has been called on for unusually large cuts of ⅛ in.

One company uses a quiet internal-gear four-speed transmission, a large engine, and obtains remarkably good, smooth car-performance. The internal-gear four-speed development is an outstanding one and was mentioned by Mr. Horning because, in his opinion, it influences the economy perhaps as much as does any factor of engine design, and favorably influences the life of the engine more than any other factor of operation or design. This year's development in steel-backed bearings is considerable, because of the better bonding of the babbitt and the steel.

Combustion-Chambers and Lubrication

With few exceptions, continued Mr. Horning, increased power and acceleration have been accomplished by higher compressions, which average 5 to 1 or higher for six-cylinder and eight-cylinder engines; special compression-ratios are used for antiknock fuel. In nearly all these cases the higher ratios have been permissible because of special timing of the spark, which has enough retard to prevent detonation at full load and on accelerating; but, owing to prompt burning, the power is not measurably reduced by this timing compromise. In the last 10 years the technique of combustion-chamber design has received increasing attention, and in Mr. Horning's opinion it is responsible for the great increases in power, economy, and acceleration found in the 1929 cars.

Attempts to clean the lubricating oil by filtering have met with some success, but there is great room for further improvement because the filters clog up very quickly and receive scant attention in service. Larger oil-pumps are common for 1929, for both slow-speed and high-speed performance.

Iron or Aluminum Pistons?

With some companies, Mr. Horning remarked, one can tell whether they are using aluminum or iron pistons this year if one knows what they used last year; and, likewise, what they will use next year. But let us be encouraged, he said, for, with each zigzag back and forth there is a steady though slow improvement in both types of piston. A great improvement has been made in the design and the weight of iron pistons; accuracy and simplicity are the features which characterize them for 1929, and the weights have been brought very close to those of properly designed aluminum pistons.

The industry has made numerous efforts to improve the mixture distribution by using various modifications of inlet and exhaust manifolds. In some cases exhaust manifolds now are led down at the front, to relieve the footboards of extreme heat in summer, a distinctly new departure and a good one, in Mr. Horning's opinion.

Valves and Cylinder Design

It is known that one of the greatest improvements in some of the best engines has come by having the passages of the valves completely surrounded by water and particularly by providing good water-circulation past the exhaust-valve seats, Mr. Horning remarked. There is an increased use of 30-deg. valve-seats to give lower gas-velocity through the valve ports. In several cases higher valve lifts have been adopted. Better valve-spring design is evident in 1929 engines, and many valve ills are thus permanently cured.

Much Neglected Oil-Temperatures

Although it is known that in several well-known engines the crankcase oil attains a temperature of 230 deg. fahr. at 30 m.p.h., and more than 300 deg. fahr. at top speed, Mr. Horning said that one misses evidences of any attempt to control these temperatures. This is one of the evils of many large main-bearings and large piston-surfaces and, sooner or later, it will be recognized and controlled. Small rotating parts, and particularly the fan, have had careful balancing attention, and this has added smoothness to the performance of nearly all 1929 engines. There is a growing use of draft ventilation of the crankcase for the control of dilution. In many cases a distinct capitulation to the customer's desires is evident and, aside from all engineering reasons, the manufacturer offers a distinct sales appeal by bowing to the social side of the buyer's nature.

Chassis Developments

In Mr. Wolf's review of passenger-car-chassis design and trends, he said that clutch developments comprise easy engagement, dissipation of heat and absorption of vibration. Clutch plates are given a slight wave to soften engagement. The foremost transmission innovation of the year is the synchromesh system. The favorable reception of the four-speed internal-gear transmission has reacted in the introduction of a three-speed unit in which the internal-gear drive is second speed, with a direct third-speed. A pressure-relief valve incorporated in the center pin of one universal-joint allows breathing action for the displacement of air caused by movement of the slip-joint. Sturdier rear-axle construction was brought about to lessen rear-end noises. The increased power-output of present engines and higher vehicle-speeds have demanded it.

A number of makers have found it desirable to have a slight excess of braking action on the front wheels, Mr. Wolf continued. One car with hydraulic brakes uses brake cylinders ⅛ in. larger in diameter at the front than at the rear. Another hydraulic and also a mechanical system use a 55-45-per cent front-and-rear distribution. Shoe and drum concentricity is essential and is obtained readily in some designs by the use of eccentric anchor-pins. An hydraulic brake-system is supplemented by a vacuum-operated booster. Sturdier drums are being used, the stock thickness being increased, which minimizes deformation. Another practice is to shrink a channel-section ring on the drum, which provides virtually constant diameter and two extra cooling-flanges. Stiffened brake-rigging, such as cross-shafts, brackets and levers, avert distortion. Cross-shafts are supported in ball-and-socket joints to prevent binding due to frame weave. To reduce friction to the minimum, roller bearings are used for supporting the camshafts and the cross-shafts.

Front Axle, Wheels and Tires

Sturdier front-axle designs are seen, I-beam sections and spindle diameters having been increased in some cases and, similarly, the knuckle-pin diameter and bushing thickness, said Mr. Wolf. The use of antifriction thrust-bearings grows. Wooden wheels have spokes of elliptic section, with the major axis in the plane of the wheel, to give more massive appearance while retaining lightness. Hubs and caps are larger.

Suspension, Frame and Control

Foremost in suspension developments is the double shackling of the front spring on the steering-gear side to reduce "wheel fight", Mr. Wolf remarked. The otherwise fixed rear-eye of the spring is supported in a trunnion or yoke which is retained in a normal neutral position by opposing coil springs which yield under and absorb road shock. Double drop-frames are becoming the by-word, although underslung front springs obviate this feature for low hanging. Increase in the section modulus of side-rails and cross-members is obtained by further flanging of the otherwise plain channel-section.

Despite the return of one maker to rigid metallic supports, rubber engine-mountings have been developed to greater refinement. One unit consists of rubber vulcanized between several steel plates, using the rubber in tension rather than in compression.

The cam-and-lever variable steering-gear ratio has been replaced by a cam-and-lever constant low-ratio in a number of cases. The flat type of steering-wheel of hard rubber molded over a flexible steel core is common practice, as is the lighting control above the wheel.

Engine Auxiliaries

Muffler mounting seems to Mr. Wolf to have a number of schools of design. One big-production job has a unit exhaust-pipe and muffler, the latter having one central support. The tail pipe forms the other member of the exhaust system. Finer radiator-core cells are used to increase the radiator volumetric and heat-dissipating capacities. Built-in thermostats operating vertical shutters are popular.

As to manufacturing, Mr. Wolf mentioned that the new chassis show metallurgical improvements, painstaking attention to all the small details of manufacture, and further progress toward greater accuracy, thereby making for smoother operation. This is forcefully impressed, he said, when we consider than one manufacturer is holding transmission gears to a tolerance of 0.0002 in. on tooth-to-tooth spacing, tooth thickness and contour of the involute curve.

Address by Herbert Austin

It is somewhat difficult to present a correct idea of the development of the car in Europe, said Sir Herbert Austin in his opening remarks. It is a subject that irks designers in England, who have been trying to get rid of the restrictions of the English method of taxation so that they can follow Americans in the effort to secure a share of the foreign trade.

Motor-car taxation based on the cylinder-bore was formerly satisfactory, the speaker said, but it has led to an engine design in which the stroke has been lengthened repeatedly and the bore made smaller. This introduced difficulties in connection with torsional vibration of the crankshaft, small water-spaces, small valves, and other problems. Many of the associations which are interested, together with manufacturers and individual users of cars, petitioned the Government to change the incidence of the tax and put it on fuel. They were very successful in getting the fuel tax imposed but, unfortunately, Parliament forgot to take off the horsepower tax.

Sir Herbert mentioned that development on the Continent has been in the direction of using six cylinders in place of four. Questions of economy and the like have made it necessary to continue using the four-cylinder engine longer than otherwise would have been done. Even today, he said, in most of the cheaper cars four cylinders are still in use. The change to six cylinders in the larger cars has been fairly rapid, and has been hastened by the success of American cars in the various Continental markets and in the British Colonies. The British industry owes a debt, he remarked, to American designers for proving that a six-cylinder car can be built cheaply and made effective in the hands of the ordinary user. There have been no other very great developments in European cars, Sir Herbert stated. Efforts are being made to bring in front-wheel drive, but have not been at all successful; he

thinks this development will not figure in the immediate future.

CHASSIS IMPROVEMENT NEEDED

Sir Herbert said that he was greatly impressed with the improvements being made this year in American cars, particularly in body work, which has been the outstanding feature in the opinion of British engineers. But he thinks there is considerable room for improvement in the design of the chassis. He notices a considerable growth in general dimensions of the car, and wonders whether American engineers will not eventually pay more attention to providing a means of transport that has considerably less weight, compared with the load it is to carry. He has been building a car that weighs about 900 lb. and will carry three persons safely and fairly comfortably over ordinary roads. This points to the possibility of a considerable reduction in the present weight of motor-cars in general. Small cars, he suggested, would eliminate some of the traffic difficulties in congested areas. American engineers, he thinks, will be able to produce a much lighter vehicle than the present one—a vehicle that will run at much lower operating cost and with satisfactory comfort.

"The conditions we have to contend with in our market are different from those in the United States," Sir Herbert remarked in conclusion, "but I believe that, in the endeavor to provide an enormous amount of car for a very small price, some of the American designers, engineers, and manufacturers are neglecting the small car. I believe that greater attention will be paid to that side of the industry in the near future."

BODY FEATURES FOR 1929

Mr. Willoughby, in his analysis of bodies, quoted numerous flamboyant advertisements of automobile companies before giving his impressions of the 1929 bodies as exemplified at the Show. The following are good examples: "This magnificent motor-car pre-empts from this moment a leadership in true grace and beauty, fully as pronounced as its undisputed championship in performance"; and "Introducing to youth and progressive Americans an entirely new line of cars with the surging power, rocket acceleration, zooming road-speeds, soaring smoothness, cushion-like riding-comfort, and the driving feel of an airplane." These and the others quoted created general hilarity.

Color, and the fact that almost all cars at the show were in lacquer finish and highly polished, afforded one of the striking features, in Mr. Willoughby's opinion. Along with the confusing brilliancy of color and luster, the second impression was effected by the chromium and nickel-plating. Additional shine and glitter were provided by the lamps on the cars. The greatest possible number of accessories seemed expected as standard equipment, such as mirrors, windshield wipers, and spare-tire shields. Front and rear ends showed marked improvement, in that certain ugly accessories such as the gasoline tank had been covered. For the most part, hoods were narrower. The radiator is coming nearer to the ground and is narrower at the top than at the bottom.

It seemed to Mr. Willoughby that the two-door sedan, or so-called coach-type sedan, is now the popular type of family car. For personal and business use, the two-passenger victoria coupé is coming into popularity. In the higher priced cars, the four-door sedan is standard. The phaeton and runabout have become distinctly special designs, and it is to these that most of the ordinarily superfluous accessories are added to increase the effect of sportiness. Mr. Willoughby then went on to describe specifically the models of various makes of car. As to body trends, he said in conclusion that it is the picture-frame effect in body building that will be striven for by designers, leaving off the details of how the product shall be molded, fitted, colored and striped.

WHAT USERS THINK OF CARS

Questionnaires sent to representative users of cars resulted in the receipt of 500 replies, said Mr. Hunt. Of these, 62 per cent reported the appearance of their cars as satisfactory. He mentioned that 38 per cent of the cars reported upon were models of 1926 or an earlier date, and that there has since been an extensive change in appearance. Regarding the body, 79 per cent reported satisfaction. In the comments reported, several mentioned adjustable front seats as being desirable, and also the provision of greater facility for older people to get into and out of cars. Riding-qualities were classified as "good" by 84 per cent of the owners. Steering qualities were classified as good by 78 per cent; brakes satisfied only 55 per cent. Engines were reported satisfactory by 81 per cent, and 76 per cent find the gear-shifting good. Lamps are considered good by 78 per cent.

The answers of 23 per cent of the owners indicate, said Mr. Hunt, that they are strongly prejudiced in favor of the cars they now own; another 20 per cent reported "no trouble", and they presumably would be prejudiced in favor of the makes of car they now have. From figures Mr. Hunt has seen, cars having a poor reputation among engineers usually have between 40 and 45 per cent of their owners willing to buy them again. The reason is that the average owner does not drive a car as hard as some others do, said Mr. Hunt, and if the satisfaction results from easy use the owner is in a frame of mind to buy another car like the one he is now driving.

Service Tools Demonstrated

Special Tools Used in Service Stations Explained at New England Section Meeting

FOUR service men brought special garage equipment to the meeting of the New England Section, held at the Engineers Club, in Boston, Jan. 16. The attendance at the meeting, which followed a dinner at the Club, was 90. The meeting was called to order by Chairman Knox T. Brown, who introduced Forest L. Mason, of the Papers Committee of the Section and instructor in the Trade School at Quincy, as the Chairman for the evening.

Slides and motion pictures from an amateur camera were used by H. V. Sweet, general service manager of the Chevrolet Motor Co., to illustrate principles of service-station arrangement and details of equipment. Mr. Sweet's work is largely of a supervisory nature over the service work of 127 New England dealers, with 30 service centers. During the last five years an attempt has been made to standardize the service equipment and methods of these dealers and service centers.

A bench full of special service-tools was brought to the meeting by C. E. Stewart, service manager of the Boston Hupmobile Co. Among those demonstrated by Mr. Stewart were a special puller for removing sticky valves, a device for holding a valve-spring without removing it while valve work is being done, and a device for holding the valve while replacing a broken spring. Some of the tools shown are applicable to various makes of car, and others could be adapted to other cars.

FLYWHEEL AND TRANSMISSION ALIGNER

Apparatus for testing and correcting the alignment between the engine, flywheel housing and transmission of a unit powerplant was shown by Frank E. H. Johnson, general service manager of the Noyes Buick Co. Mr. Johnson said that misalignment is indicated in cases of a noisy clutch-throw-out bearing, clatter in clutch plates when the

clutch is disengaged, bad wear of clutch plates at the driving studs or serrations, worn transmission front-bearing, and knocking that occurs upon declutching when first or second-speed gears are engaged. In addition, the alignment should be checked when any welding work is done on the flywheel housing or the crankcase or when a new flywheel housing is installed.

Checking is done by means of a dial indicator, which can be mounted on the housing to check the truth of the flywheel, on the flywheel to check the mounting flange of the housing, or on a bar to check the mounting flange of the transmission. Trouble with the transmission housing is not common, but flywheel housings sometimes are found to have warped out of shape in the stockroom.

After any misalignment has been located by means of a dial gage, it can be corrected by a tool which takes a scraping cut, also shown by Mr. Johnson. For the larger service stations this tool can be driven by an electric motor, but it is not difficult for two men to operate it by hand if the volume of work is not sufficient to warrant the purchasing of a motor.

The final speaker was Mr. Anderson, foreman in the service department of the Danker & Donohue Co., which maintains several garages in and around Boston. He showed a universal set of dummy brake-drums that are of great assistance in the accurate adjusting of brakes. With them, he said, it is possible to adjust the clearance much more accurately than with the wheel in place.

Aviation Fuel and Maintenance

Chicago Section Aviation Division Hears Barnard on Fuels and Moffett on Engine Care

MEETING after a dinner at the Clearing Club at the Municipal Airport, the Aviation Division of the Chicago Section held its first independent meeting on Jan. 8, the first meeting of the new Division having been held in connection with the National Aeronautic Meeting at the time of the Aviation Show in Chicago last December. Owing to the absence of Chairman Seymour, of the Division, Vice-Chairman F. M. Say presided. Music by a quintet from the Standard Oil Co. was a much appreciated feature.

The meeting was opened by Chairman J. W. Tierney, of the Section. H. F. Bryan was elected as alternate Section representative on the Nominating Committee of the Society. Chairman E. W. Stewart, of the Meetings and Papers Committee, announced plans for the Section meeting of Jan. 29, during the Chicago Automobile Show. After Mr. Say assumed the chair, E. A. Sipp was elected to serve as Secretary of the Aviation Division.

The Significance of Aviation Fuel Specifications was the title of the first paper of the Jan. 8 meeting, read by D. P. Barnard, 4th, research engineer of the Standard Oil Co. of Indiana. Mr. Barnard said that the Government specifications, which are the only ones commonly used, are designed to guard against fuel troubles rather than to assure efficient fuel. In fact, the precautions are so great that they sometimes penalize the performance characteristics.

Large users of aviation fuels sometimes encounter engine troubles, he continued, that can be explained only by something connected with the fuel, perhaps its character or non-uniformity of distribution. Tests for important properties of fuels include distillation, sulphur and contamination tests, which are called for or implied in the standard specifications, and tests for detonation and gum, and occasional tests for characteristics that will determine the source of the fuel.

The only test included in the Government specification which determines the actual combustion and distribution characteristics is the distillation test, which gives information on several important points: The 10-per cent point measures starting characteristics; the 90-per cent point is most important, indicating the distribution characteristics and roughly the detonation characteristics; and tendency to form vapor pockets in the fuel system and the handling hazard are shown by the initial boiling-point. The sulphur test is of importance in preventing corrosion, particularly of parts in the valve-gear housing, and imposes no hardship on the fuel manufacturer.

Detonation Tests Important

While no mention of detonation characteristics is made in the Government specification, tests for this are of great importance. Fuel producers generally use water-cooled engines for such tests, because of the difficulty of duplicating results with air-cooled engines, according to the speaker, but it is necessary to establish a relationship between such tests and the more laborious and expensive tests on air-cooled engines of large bore, since it is with these engines that the detonation characteristics are more important.

There is a lack of uniformity in tests for gum in gasoline. The Government copper-dish-corrosion test assures freedom from any appreciable amount of gum-forming constituents, but excludes some fuels that are most desirable for their anti-detonation characteristics and for freedom from gum-forming troubles. One convenient test, called the steam-oven test, consists in evaporating a sample of the fuel in a glass dish in an atmosphere of steam, thus avoiding the catalytic effects of the copper dish.

Some Tests Not Significant

Government specifications for color, doctor, corrosion and acidity were said by Mr. Barnard to have no bearing on engine operation, and consistent results cannot be expected. The doctor test, for instance, is supposed to indicate the sulphur content, but the results are very inconsistent. A modification of the copper-dish-corrosion test is suggested as more significant and useful. Other tests that are sometimes made for specific gravity and tendency to dissolve in sulphuric acid are said to be useless. When all the gasoline was produced by distillation from Pennsylvania crude, gravity and volatility were proportional; but this is not true now.

In reply to a question, Mr. Barnard said that a deposit sometimes found in the cylinders of engines using tetraethyl-lead dope is due to the formation of litharge. When this dope was first introduced, a chlorine compound was included to clean up this deposit. This was not sufficiently effective, however, and a bromide has been substituted. The litharge deposit may be of almost any color, depending upon temperature and conditions of oxidation. Mr. Barnard also said that only in case of fuels from the same source is it safe to say that more volatile fuel will cause less detonation.

Air-Cooled Engine Maintenance

Robert Moffett, of the Wright Aeronautical Corp., followed with a short talk on the maintenance of radial air-cooled engines. He said that the basic design of the latest J-6 Wright engine is the same as that of the original J-1, but several changes have been made in cylinder design and arrangement of exterior parts to facilitate streamlining. Accessories and valve mechanism are now placed at the rear.

The J-5 engine weighs 515 lb. and develops 200 hp. at 1800 r.p.m. The new nine-cylinder J-6 weighs 30 lb. less and develops 300 hp. at 2000 r.p.m., with lower fuel consumption. This difference in power results mainly from a larger cylinder-bore and the use of a rotary distributer. The J-6 engine is made also in 150-hp. five-cylinder and 225-hp. seven-cylinder forms, about 94 per cent of the parts being interchangeable.

Most of the trouble experienced with radial air-cooled engines has to do with cooling and installation, particularly of the fuel and oil lines, said Mr. Moffett. As much of the cooling trouble has been due to improper cowling, the Wright company has adopted the policy of furnishing cowling and exhaust manifolds for the engines.

Discussion of this address centered in questions of shielding the electric wiring to prevent interference with radio operation, and with difficulties from vapor lock in the fuel pipes. The shielding seems to be a problem not completely solved, as it is clumsy and not entirely effective. Vapor lock was said to be caused by air and other gases dissolved in the gasoline, and to hydrocarbons of high volatility which form bubbles at high points in the fuel line. Such bubbles interfere with the fuel feed, particularly when it is gravity feed.

To Aid Airport Development

Section Chairman Tierney introduced the question of what the Division can do to further the development of the Chicago airport. He reported that Chicago is behind St. Louis, Kansas City and other cities in such development, and said that further work does not seem likely by means of a public bond-issue. Financing to the extent of about $200,000 is needed, and Mr. Tierney believes that several of the leading newspapers and many of the prominent business men in the city can be aligned behind a suitable project.

After considerable discussion, participated in by Secretary Lee W. Oldfield, Chairman Say, J. P. McArdle, P. B. McGinnis and F. C. Mock, a vote was passed authorizing a committee to call on some of the newspaper men and formulate a policy; and Chairman Say appointed on this committee Chairman Tierney, Secretary Sipp, Mr. McArdle and Mr. Mock.

A Symposium on Metals

FOUR papers on metals and metallurgy provided the heavy menu for digestion at the Jan. 18 joint meeting of the Southern California Section and the Western Metal Congress in Los Angeles. The only light subjects were a paper on Aluminum as Applied to the Automobile and Airplane Industries, by Dr. Zay Jeffries, of the Aluminum Co. of America, and one on Some Phases of Aircraft Construction. The three pieces de resistance were Metallurgical and Heat-Treating Problems in Motor-Car Manufacture, by J. M. Watson, of the Hupp Motor Car Co.; The Production of Nickel-Steel Castings by the Electric-Furnace, by E. Favary—a rather hot course; and The Manufacture and Heat-Treatment of Automotive Leaf Springs, by J. B. Rauen, of the United States Spring Co., which might be classed as a lively subject.

As the detailed report of the meeting had not been received at the time of closing the forms for this issue of The Journal, it is not known whether the digestion of the attendants was sufficiently strong to enable them to be active in discussion after each course was served.

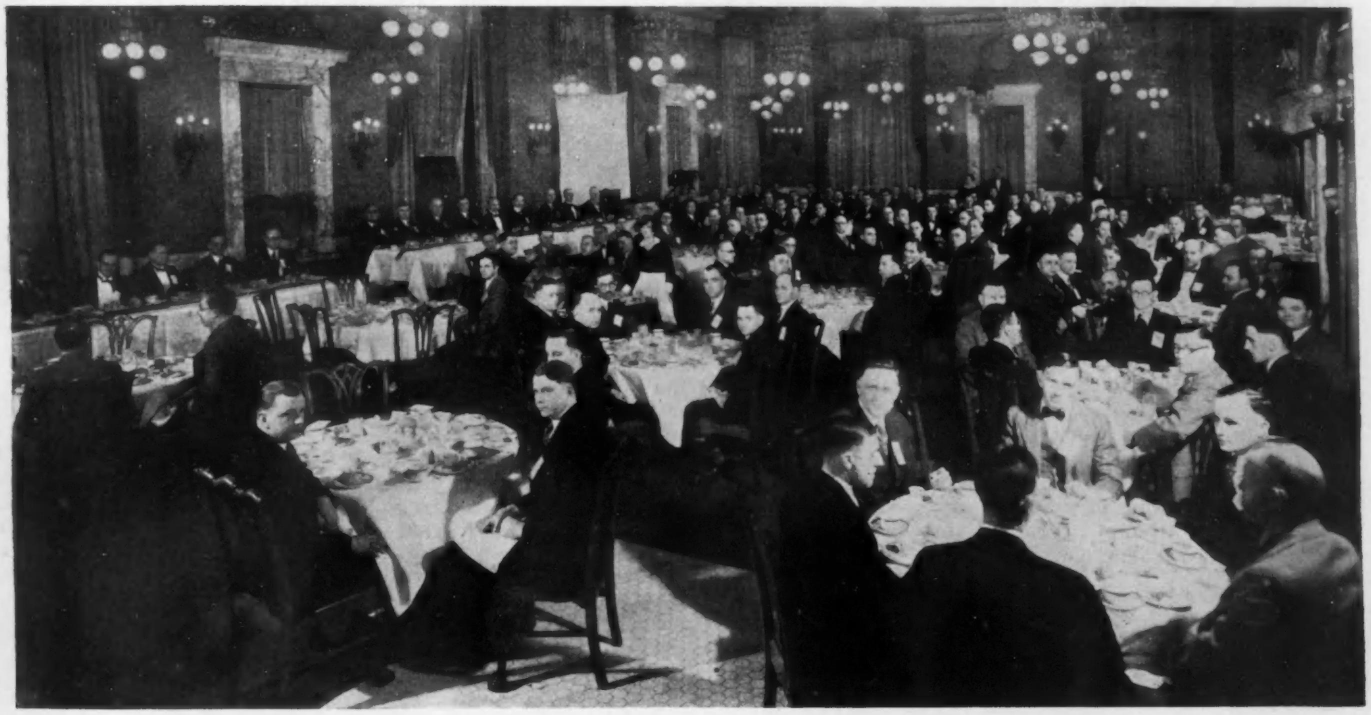
Northwest Section Elects Officers

OFFICERS nominated at the organization meeting of the new Northwest Section in December, as reported in the January issue of the S.A.E. Journal, p. 105, were elected to office for the 1929-1930 Section year at a second meeting, held Jan. 19 at the Bergonian Hotel in Seattle, Wash.

Secretary A. M. Jones reported to The Journal that the 50 members, applicants for membership in the Society, and guests who were in attendance were addressed by Secretary J. E. Hoffman, of the Seattle Automobile Dealers Association. Sherman W. Bushnell then read a paper on ignition that had been presented before the Detroit Section, followed by discussion on the subject.

Fred P. Landau, of the Boeing Airplane Co., presented a paper on aircraft production methods, which was also discussed.

The next meeting of the Northwest Section is to be held at Portland, Ore., on Feb. 16, and will be preceded by a members' dinner. At this meeting A. N.



Organization Dinner of the Northwest Section of the Society at Seattle on Dec. 15

Among Those at the Speakers' Table Are Robert S. Taylor, Who Presided and Was Nominated for Chairman of the New Section; Floris Nagelvoort, Vice-President of the Seattle Chamber of Commerce; the Secretary to the Mayor of Seattle; Ethelbert Favary, of the Southern California Section, Who Represented the S.A.E. and Was the Principal Speaker; Prof. F. G. Baender, Nominated for First Vice-Chairman; Valentine Gephart and Earl B. Staley, Nominated for Second Vice-Chairman; A. M. Jones, Nominated for Secretary; George F. Morrisey, Nominated for Treasurer; and P. E. Sands, Seattle's Oldest Automobile Dealer

Day, of the Goodyear Tire & Rubber Co. of California, is to give a paper on Motorcoach and Truck Tire Change-Over and Subsequent Problems.

Alfaro Corrects Misstatements

IN connection with the news report of the Milwaukee Section meeting of Dec. 5, published in the January number of the S. A. E. JOURNAL, Heraclio Alfaro calls attention to typographical errors or reporter's mistakes in the last paragraph on p. 100. Instead of saying that "few airplanes can be landed at speeds less than 55 m.p.h.," Mr. Alfaro states that, while most airplanes have a theoretical landing speed of about this figure, some have a landing speed as low as 40 and perhaps 38 m.p.h.; none, however, to his knowledge, can land at 35 m.p.h. Probably because of phonetic similarity of the figures, his statement that he "expects to obtain a maximum flying speed of 115 m.p.h.," was reported as "150 m.p.h."

Oil-Filter Tests Reported

Professor Hoffman Tells Northern California Section About University Farm Studies

ABOUT 60 members and guests of the Northern California Section met at the Engineers Club in San Francisco, Jan. 10, to hear Prof. A. H. Hoffman, of the Agricultural Division of the University of California, give a partial report on tests of oil-filters that are being conducted at the University Farm, Davis, Calif.

At the close of the dinner which preceded the meeting, each person present responded to a roll-call by rising. Announcement was made that the next meeting of the Section will be held at the University of California, in Oakland. About two-thirds of those present at the January meeting came from Oakland, and it was predicted that the attendance at the February meeting will be about 250. Owing to conflict of the present regular meeting night—the second Thursday in the month—with meetings of the Service Managers' Association of San Francisco and other organizations, a change to the first Tuesday in the month is being considered.

Because all the oil-filter tests were not complete, Prof. Hoffman was unable to give a paper with a complete report of the findings, but he expects to make the paper complete for publication in THE JOURNAL. The work includes a study of the construction and principles of operation of various oil-filters, their efficiency, the troubles to which they are subject, and an attempt to find out just what is removed from the oil and the results of the use of oil-filters in engine wear and oil economy. Some of the data are being secured from a considerable number of filters taken from vehicles of the State Highway Commission, submitted by R. H. Stalnaker, of Sacramento, including complete data as to the vehicles on which they were used and the gasoline and oil consumed.

SOME OBSERVED RESULTS

Oil-cleaners on typical passenger-cars have been found to remove from $1\frac{1}{2}$ to $2\frac{1}{2}$ grams of solid impurities from oil per 1000 miles. In some cases the filtering elements had become ruptured, and the amount of material filtered out was very much less. The rupturing was thought to result in some cases from acidity of the oil. Instances have been observed, also, in which the filters were allowed to run too long without cleaning or renewing the elements. One of the units submitted had been on a car for 25 months, during which it had run more than 53,000 miles.

Claims have been made that oil dilution will be very much less with oil-filters because of a sort of catalytic action on the part of the carbon in crankcase oil which is prevented by the filtering out of the carbon. Professor Hoffman does not hold this view, but hopes to test it. He does believe that an ordinary oil-filter will resist the passage of water, once the filter has become soaked with oil.

Some tests of piston-ring wear, by weight, have indicated a reduction of about 50 per cent in wear resulting from the use of oil-filters. Tests in continuous service have shown that, even with short runs, the oil can be kept in good condition with reference to viscosity and acidity by means of an oil-filter, without periodic renewal of the oil.

SEVERAL OIL-FILTERS DESCRIBED

Several of the leading oil-filters were described by members and guests. In most cases either samples or drawings, or both, were available. Among those described were the Hall-Winslow, Hardy, Purolator, Cuno and Kingston. Regarding the first, A. H. Laufer, of the Lathan Co., said that its filtering element is composed of a series of felt rings, like axle washers, assembled on a perforated hollow tube. One of its features is that, after the unit has become fouled, a plug can be removed at the bottom and an air hose connected at the top to blow out any sludge and water that have accumulated.

W. W. McDonald, of McDonald Motors, discussed the Kingston filter. Like the Hall-Winslow, this contains no element that requires renewal, and its first cost is necessarily comparatively high. It was said not to be suitable for application as an accessory except when included in the original design of an engine. One of its features is that air is drawn through the oil to overcome the effect of dilution. The filter draws oil from the bottom of the oil pan, below the inlet to the oil-circulating pump. This prevents circulation of the contaminated oil through the crankshaft and other parts of the circulating system.

In reply to a question about measurement of viscosity, Professor Hoffman described a testing apparatus consisting of a glass tube, about 20 in. long, chosen for its uniformity of bore. This is surrounded by a steam jacket open to the air, by means of which the oil is heated to a temperature of 210 deg. The standard ball from a Brinell hardness-testing machine is then released in the top of the tube, and the viscosity is measured by a stop-watch which shows the time required for the ball to reach the bottom. This has been found to give good results with samples of oil drained from filters, but not with those drained from crankcases, because of the dirt in the oil.

Personal Notes of the Members

Whitten New McCord Chief Engineer

Frank A. Whitten assumed recently the duties of chief engineer of the McCord Radiator & Mfg. Co., of Detroit. Mr. Whitten, who held his first engineering position as draftsman for the Buckeye Engine Co., Salem, Ohio, in 1898, has since attained remarkable success in his chosen field. His first connection with the automotive industry was as superintendent and later as chief engineer for the Lansden Co. of Newark, N. J., one of the early manufacturers of electric commercial vehicles. He subsequently joined the Worthington Pump Co., and remained in its service for about ten years, engaging in experimental testing, erecting and sales work. He was chief engineer of the General Motors Truck Co. for eight years, and during the last two years has been chief engineer of the American Car & Foundry Motors Co., in Detroit.

Mr. Whitten was elected to membership in the Society in 1912, and four years later joined the Detroit Section. The Society has benefited greatly by his participation in the activities of the Standards Committee. For nine years he was a member of the Truck Division, acting as Vice-Chairman and Chairman of this Division in 1921 and 1922, respectively. He served six successive terms on the Springs Division, and has been a member at various times of the Electric Vehicle, Motorcoach, and Motor-Truck Divisions. For the last two years he has been Chairman of the last-named Division. He was twice elected to serve on the Highways Committee, and in 1926 was appointed Chairman of the Standards Committee. The following year he was elected to membership on the Special Committee on Standardization Policy. Mr. Whitten has also contributed valuable support to Section activities, serving as Vice-Chairman of the Detroit Section in 1917.

FRANK A. WHITTEN

Allen Joins Auburn Company

Edwin L. Allen, Jr., has resigned as designer with the Chandler-Cleveland Motors Corp., of Cleveland, to accept a position in the engineering department of the Auburn Automobile Co., in Auburn, Ind. Prior to joining the Cleveland Automobile Co. in 1921, Mr. Allen was successively employed in a designing capacity by the F. B. Stearns Co., Delcon Motor Co. and the H. J. Walker Co., all of Cleveland. Following his resignation from the Walker Co., he became associated with E. H. Sherbondy, a consulting engineer of Cleveland. Seven years ago he entered upon his service with the Cleveland Automobile Co., which later became the Chandler-Cleveland Motors Corp.

Mr. Allen joined the Society and the Cleveland Section in 1925. During his membership he has been particularly active in the administration of Section affairs and, until his recent change of position and subsequent withdrawal from the Cleveland Section, he acted as Secretary of his Section. He was also editor of the *Junior Journal*, a Cleveland Section publication.

Oldfield Forms Aircraft Co.

Lee W. Oldfield recently announced the severance of his connection, established in 1923, with the Package Car Corp., of Chicago, to become chief engineer of the Oldfield Aircraft Engine Co., in Chicago. His unusually comprehensive experience has provided Mr. Oldfield with a thorough knowledge of engineering matters. Prior to the World War, he served in the experimental, sales and service departments of various automotive concerns. During the war, he was a Captain in the United States Air Service and acted as chief inspector of the Production and Maintenance Division of the Air Service in France. Returning home in 1920, he accepted a position in the engineering department of the Frankford Motors Co., of Philadelphia, and subsequently became identified successively with the Motor Efficiency Co., the Northern Motors Corp. and, in 1923, with the Pak-Age-Kar Corp., for which he acted in a consulting capacity until his recent resignation.

LEE W. OLDFIELD

A Member since 1913, Mr. Oldfield has cooperated in many ways in the meetings and administrative work of the Society. This year he is serving as Secretary of the Chicago Section, of which he became a member in 1925, when the Mid-West Section was reorganized as the Chicago Section. An interesting contribution to Society literature was made by Mr. Oldfield in the form of a paper entitled, A Motor-Vehicle for House-to-House Deliveries, published in the January, 1928, issue of the S.A.E. JOURNAL.

Carl Abell, who until lately acted as assistant district manager of the American Car & Foundry Motors Co. in Los Angeles, is now with the Hall-Scott Motors Co., Berkeley, Calif.

Eric Almquist recently left the employment of the Curtiss Aeroplane & Motor Co., in Buffalo, where he acted as draftsman, to accept a similar position with the Warner Aircraft Corp. in Detroit.

Elmer H. Babel has resigned his position as mechanical engineer with Maloon & Babel, of Oakland, Calif., to join the Killefer Mfg. Corp., of Los Angeles, in a similar capacity.

Vladimir Babikoff, previously connected with the engineering department

(*Continued on p.* 34)

Applicants Qualified

The following applicants have qualified for admission to the Society between Dec. 10, 1928, and Jan. 10, 1929. The various grades of membership are indicated by (M) Member; (A) Associate Member; (J) Junior; (Aff.) Affiliate; (S M) Service Member; (F M) Foreign Member.

AFFLECK, BERTRAM L. (A) 55 West 55th Street, *New York City*.

BAKER, LYNNE EARL (M) staff engineer, Sinclair Refining Co., New York City; (mail) 5505 Everett Avenue, Hyde Park, *Chicago*.

BALDWIN, WILLIAM L. (M) draftsman, Durant Motor Co., Elizabeth, N. J.; (mail) 88 Lyon Place, *Lynbrook, N. Y.*

BARRY, WILLIAM W. (A) sales representative, Crowe Name Plate & Mfg. Co., Chicago; (mail) 4835 Woodward Avenue, *Detroit*.

BEAUMONT, EUGENE GUY EUSTON (F M) motor superintendent, Anglo American Oil Co., Ltd., London, England; (mail) 10 Bentwick Mansions, Bentwick Street, *London, W. 1, England*.

BELL, D. E. (A) president, general manager, Bell-Dahler Machine Co., *Seattle;* (mail) 1013 East Pike Street.

BEYER, RAYMOND H. (J) layout man, airplane brakes, wheels, Bendix Brake Co., *South Bend, Ind.;* (mail) 1338 East Minor Street.

BIKLE, WILLIAM F. (M) superintendent, M. P. Moller Motor Car Co., *Hagerstown, Md.*

BOONE, CAPT. MILTON O., U. S. A. (S M) Fourth Motor Repair Battalion, Quartermaster Corps, *Presidio of San Francisco*.

BORNHOLT, O. C. (M) vice-president, Oakes Products Corp., 3019 Roosevelt Avenue, *Indianapolis*.

BRAMBERRY, HARRY M. (M) engineer, Perfect Circle Co., Hagerstown, Ind.; (mail) 5-214 General Motors Building, *Detroit*.

BRILL, ELKANAH H. (A) body-design draftsman, Hudson Motor Car Co., Detroit; (mail) 220 Geneva Avenue, *Highland Park, Mich.*

BROWN, FRED LEROY (A) proprietor, Brown's Buick Service, 61 South Lexington Avenue, *White Plains, N. Y.*

BUICK MOTOR CO. (Aff.) *Flint, Mich.* Representative: Gayer, Albert L.

COLLINS, ROBERT J. (A) transportation engineer, Kansas City Power & Light Co., 5106 Park, *Kansas City, Mo.*

DAGENAIS, J. EDWARD (A) active service representative, chief inspector, General Motors Export Co., *Montevideo, Uruguay, South America*.

DAGNER, EDWARD (A) factory representative, Fageol Motor Co., *Oakland, Calif.;* (mail) 3801 Rhoda Avenue.

DAUB, RUDOLPH (J) designer, checker, Durant Motor Co. of New Jersey, Elizabeth, N. J.; (mail) 64 Grace Street, *Irvington, N. J.*

DAVIDSON, WILLIAM H. (J) motorcycle manufacturing, Harley-Davidson Motor Co., *Milwaukee;* (mail) 5010 Washington Boulevard.

DECROW, V. R. (A) vice-president, Decrow Automotive Specialties, Inc., *Lockport, N. Y.;* (mail) 69 Lock Street.

DENISON, RALPH P. (A) foreman automobile repairs, City of Seattle Lighting Department, *Seattle;* (mail) 6318 Rainier Avenue.

DONALDSON, J. G. (A) sales engineer, Long Mfg. Co., 2768 East Grand Boulevard, *Detroit*.

DOUGLAS, E. M. (J) engineering representative in production, Studebaker Corp. of America, *South Bend, Ind.;* (mail) 905 North Lawndale.

DRAKE, H. W. (A) superintendent of garage, service station, Portland Gas & Coke Co., *Portland, Ore.;* (mail) 495 East 30th Street, North.

DUNN, RAYMOND E. (J) layout draftsman, Chevrolet Motor Co., *Detroit;* (mail) 7370 Hanover Street.

EMMONS, CLAUDE E. (M) engineering chemist, The Texas Co., 929 South Broadway, *Los Angeles*.

FINN, CHARLES C. (A) local agent for the Northwest, John Finn Metal Works, San Francisco; (mail) 1934 Railroad Avenue, *Seattle*.

GOLDEN, JOHN O. (A) road engineer, International Harvester Co., 606 South Michigan Avenue, *Chicago*.

GREEN, LEE BRITTON (M) development engineer, Borden Co., Warren, Ohio; (mail) 2130 Lakeland Avenue, *Lakeland, Ohio*.

GUY, FLOYD (J) full-sized-body draftsman, Pierce Arrow Motor Car Co., *Buffalo;* (mail) 159 Virgil Avenue.

HALIK, EMIL F. (A) master mechanic, Oregon State Highway Shops, *Salem, Ore.*

HARRINGTON, ELVIN E. (J) engineering records, International Motor Co., *Allentown, Pa.;* (mail) Room 701, Y. M. C. A.

HAYNES, OMER (A) foreman, Tacoma Bus Co., *Tacoma, Wash.;* (mail) 3519 South Ash Street.

HERTRICH, FREDERICK W. (M) executive engineer, Buick Motor Co., *Flint, Mich.*

HILL, JOHN G. (A) service manager, 116 Alexander Avenue, *Yonkers, N. Y.*

HOHN, CHARLES O. (A) industrial sales engineer, American Hammered Piston Ring Co., Baltimore, Md.; (mail) 7338 Woodward Avenue, *Detroit*.

HOWARD, WILLIAM S. (M) engineer, production manager, B. Nicoll & Co., Inc., 292 Madison Avenue, *New York City*.

HULT, DEWEY E. (M) mechanical engineer, draftsman, Auto Engine Works, Inc., 349 North Hamline Avenue, *St. Paul*.

HUNN, SIDNEY M. (J) production department, Fairchild Airplane Mfg. Corp., Farmingdale, N. Y.; (mail) 334 Carnation Avenue, *Floral Park, N. Y.*

HUTCHENS, EDWARD (M) president, Utility Mfg. Co., *Cudahy, Wis.*

HYDE, J. VERNE (A) airport manager, construction superintendent, County of King, State of Washington, Boeing Field, Georgetown Station, *Seattle*.

ISELER, CHARLES W. (M) research engineer, General Motors Corp. Research Laboratories, *Detroit;* (mail) 464 Greendale Avenue, West.

KINKADE, T. H. (M) sales engineer, Lycoming Mfg. Co., *Williamsport, Pa.*

KLING, NELSON G. (J) draftsman, Stewart Motor Corp., *Buffalo;* (mail) 26 South Putnam Street.

LITTLETON, JACK LLOYD (A) sales manager, Simplex Piston Ring Co. of America, Inc., *Cleveland;* (mail) 3803 Tremont Street.

LLOYD, REESE (A) superintendent, Sunset Electric Co., 11th and Pine Streets, *Seattle;* (mail) 5225 Fontonelle Place.

LORANGER, LOUIS J. (A) salesman, Long Mfg. Co., 2768 East Grand Boulevard, *Detroit*.

LOVEJOY, FRANK W. (A) manager, Vacuum Oil Co., 61 Broadway, *New York City*.

LUNNON, JAMES (A) maintenance engineer, Rolls-Royce of America, Inc., *Springfield, Mass.;* (mail) Apartment 207, 774 State Street.

MACY, FRANK H. (A) sales application work, special service representation, A.C.E. Shop, Inc., *Chicago;* (mail) 1216 East 54th Street.

MARSHALL, FURBER (A) president, general manager, National Brake Service, Inc., Room 2121, 105 West Adams Street, *Chicago*.

MATHIS, CLYDE C. (M) district service manager, The White Co., 458 Melwood Street, *Pittsburgh*.

MEADER, J. W. (A) General Motors Export Co., 1775 Broadway, *New York City*.

MILLER, WALLACE T. (A) director, sales engineer, Lundelius & Eccleston Motors Corp., 3160 Wilshire Boulevard, *Los Angeles*.

MOORE, ROLLA WILBUR (M) district manager, The White Co., Box 4206, *Portland, Ore.*

MUNTER, HERBERT A. (A) president, Seattle Auto Rebuild, 1406 Broadway, *Seattle*.

NORTHRUP, AMOS EARL (M) chief designer, Willys-Overland, Inc., *Toledo, Ohio;* (mail) Park Lane Apartments.

ORR, JOHN M. (A) general manager, Equitable Auto Co., 214 Lexington Avenue, *Pittsburgh*.

OSBUN, I. J. (A) assistant director sales, E. I. duPont de Nemours & Co., Inc., Wilmington, Del.; assistant to president, duPont Viscoloid Co., New York City; (mail) 5-233 General Motors Building, *Detroit*.

OTWELL, RALPH B. (M) experimental engineer, 15367 Brace Avenue, *Detroit*.

PARKER, HARRY D. (A) manager, automotive chain division, Ramsey Chain Co., Inc., Albany, N. Y.; (mail) Box 413, *Delmar, N. Y.*

PHILIPPBAR, FRANK JAY (M) chief chemist, lubrication engineer, Kendall Refining Co., P. O. Box 364, *Bradford, Pa.*

POLLOCK, CHARLES R. (A) salesman, Thornton-Fuller Auto Co., Philadelphia; (mail) Southmore Court, *South Ardmore, Pa.*

ROBERTS, CLIFFORD E. (J) assistant automotive engineer, research laboratory, Atlantic Refining Co., *Philadelphia;* (mail) 2018 North Carlisle Street.

ROBERTS, H. W. (A) secretary, treasurer, manager, Roberts Motor Car Co., Inc., *Portland, Ore.;* (mail) 325 Pacific Street.

ROESCH, GEORGES HENRY (F M) chief engineer, Clement Talbot, Ltd., London, England; (mail) 4 Jr. Cuthbert's Road, *London, N. W. 2, England*.

SAVAGE, J. VERN (A) superintendent, municipal shop, City of Portland, *Portland, Ore.;* (mail) 541 Powell Street.

SCHAEFFERS, JOSEPH (M) P. O. Box 198, *Wichita, Kan.*

SCHLIEKER, CAPT. GRANT A. (S M) instructor, heavy mechanical and maintenance school, Tank School, *Fort Leonard Wood, Md.*

SCHMUTZ, E. R. (A) proprietor, service manager, Chrysler Service, 512 Santa Clara Street, *Vallejo, Calif.*

SHAILER, PHILIP B. (A) factory manager, William D. Gibson Co., 1800 Clybourn Avenue, *Chicago*.

SHERER, G. D. (A) garage foreman, Standard Oil Co. of California, *Portland, Ore.;* (mail) 931 Raleigh Street.

SPEARS, CHARLES C. (A) supervisor, Oregon automotive department, Shell Co. of California, 1020 Chamber of Commerce Building, *Portland, Ore.*

STEVENS, GEORGE C. (A) manager, St. Louis branch, Diamond T Motor Car Co., *St. Louis;* (mail) 720 Interdrive.

STEVENS, HOY (M) assistant superintendent, maintenance, motorcoach department, Cleveland Railway Co., 1809 St. Clair Avenue, *Cleveland*.

STRYKER, CARLETON ELWOOD (M) manager, engineer, Western College of Aeronautics, 154 West Slauson Avenue, *Los Angeles*.

SULLIVAN, H. F. (A) garage superintendent, Northwestern Electric Co., *Portland, Ore.;* (mail) 1223 East 12th Street, North.

SWAYZE, ERNEST HAROLD (A) district service manager, Studebaker Corp. of America, *Portland, Ore.;* (mail) R. 5, Box 260.

TAMARELLI, ALBERT J. (A) chief inspector, Budd Wheel Co., *Detroit;* (mail) 12141 Charlevoix Avenue.

THURNER, R. J. (M) president, general manager, Thurner Heat Treating Co., 485 National Avenue, *Milwaukee*.

Applicants for Membership

The applications for membership received between Dec. 15, 1928 and Jan. 15, 1929, are listed below. The members of the Society are urged to send any pertinent information with regard to those listed which the Council should have for consideration prior to their election. It is requested that such communications from members be sent promptly.

Albinaik, A. S., assistant engineer, body department, Cadillac Motor Car Co., *Detroit.*

Alvey, John C., chief inspector, Durant Motors, *Leaside, Ont., Canada.*

Baker, Malvern S., draftsman, Bendix Brake Co., *South Bend, Ind.*

Baker, William E., draftsman, Ford Motor Co., *Dearborn, Mich.*

Baldwin, Timothy, Jr., supervisor of delivery, Purity Bakeries Service Corp., *Chicago.*

Beattie, George J., president, Auto Electric Service Co., Ltd., *Toronto, Ont., Canada.*

Boardman, Myron E., instructor of mechanics, inspector of automotive equipment, The Southern New England Teleprone Co., *New Haven, Conn.*

Bollack, Lucien Armand, manager, Cifada, 12 rue des Sablons, *Paris, France.*

Breckinridge, Richard, vice-president, traffic, Cincinnati, Hamilton & Dayton Railway Co., *Cincinnati.*

Brown, Clark H., automotive engineer, The Texas Co., *New York City.*

Butler, William Lawrence, vice-president, Cincinnati, Hamilton & Dayton Railway Co., *Philadelphia.*

Cartwright, Dale P., sales engineer, North East Electric Co., *Rochester, N. Y.*

Charles, Maurice, ingenieur aux Usines Delage administrateur directeur technique, Ste. Charles, *Courbevoie, (Seine) France.*

Christensen, Rasmus, airplane and engine inspector, Bureau of Standards, *City of Washington.*

Chutorash, Gustave, body engineer, Fisher Body Corp., *Detroit.*

Compher, C. M., automotive engineer, Tide Water Oil Sales Corp., *Detroit.*

Compton, J. C., Detroit branch manager, General Motors Truck Co., *Pontiac, Mich.*

Cowardin, Harry Alfred, mechanical engineer, Cowardin Mechanical Laboratory, *Richmond, Va.*

Day, James Robert, chief draftsman, Wyman-Gordon Co., *Harvey, Ill.*

Dennison, Herbert J. S., patent attorney, 1007 Federal Boulevard, *Toronto, Ont., Canada.*

de Sakhnoffsky, Alexander, art director, Hayes Body Corp., *Grand Rapids, Mich.*

Diedrichs, German C., aeronautical engineer, Aircraft Development Corp., *Grosse Ile, Mich.*

Eddy, Raymond William, electrical engineer, Chrysler Corp., *Detroit.*

Engel, William, technical representative, parts and service department, General Motors of Canada, Ltd., *Oshawa, Ont., Canada.*

Feltham, Fred F., service manager, Los Angeles Creamery Co., *Hollywood, Cal.*

Frank, Clarence E., draftsman, Ford Motor Co., *Dearborn, Mich.*

Furst, Clarence F., student, Packard Motor Car Co., *Detroit.*

Galbraith, W. M., service manager, Gregg Motor Co., *Tulsa, Okla.*

Gorshkoff, Alexis S., calculating engineer, Gates-Day Aircraft Corp., *Paterson, N. J.*

Grafton, Elmore Hill, draftsman, American Car & Foundry Motors Co., *Detroit.*

Green, Frank F., shop foreman, Commercial Transfer Co., *Fresno, Cal.*

Hards, Alfred T., body draftsman, Ford Motor Co., *Dearborn, Mich.*

Hawthorne, Leo S., lubricating engineer, Sinclair Refining Co., *New York City.*

Hayden, A. A., engineer, Carter Carburetor Corp., *St. Louis.*

Heath, Robert Lee, draftsman, Lycoming Mfg. Co., *Williamsport, Pa.*

Heinrich, Herbert William, assistant superintendent engineering and inspection division, Travelers Insurance Co., *Hartford, Conn.*

High, Carl F., proprietor, High Engineering Co., *Madison, Wis.*

Hodgkins, H. Follet, manager, secretary and treasurer, W. C. Lipe, Inc., *Syracuse, N. Y.*

Holmen, Erling, checker body engineering, Pierce-Arrow Motor Car Co., *Buffalo.*

Hopkins, Thomas, foreman inspector, General Motors Corp. of Canada Ltd., *Oshawa, Ont., Canada.*

Hughes, James W., staff engineer on special development work, Chrysler Corp., *Detroit.*

Hulbert, Edward A., layout and design draftsman, Packard Motor Car Co., *Detroit.*

Hurrell, Berton R., sales manager and field engineer, Willis Jones Machinery Co. Inc., *Seattle.*

James, Frederick Ernest, manager, French Motor Car Co. Ltd., *Bombay, India.*

Jones, Ralph F., mechanical engineer, Russell Mfg. Co., *Middletown, Conn.*

Kerr, Wade H., *Spiceland, Ind.*

Kopp, Roger S., consulting engineer, Murray Automatic Transmission Co., *York, Pa.*

Kullmann, Earl L., assistant superintendent, Wadhams Oil Co., *Milwaukee.*

Lambert, Arthur R., draftsman, Gates-Day Aircraft Co., *Paterson, N. J.*

Lee, Chite C., student training course, International Harvester Co., *Chicago.*

Lewis, John B., inspector of motorcoach division, Key System Transit Co., *Oakland, Cal.*

Liggett Spring & Axle Co., *Monongahela, Pa.*

Loose, Theron L., general superintendent, Indian Motocycle Co., *Springfield, Mass.*

Marshall, Albert C., draftsman, Handy Governor Corp., *Detroit.*

Martin, Lewis William, Boston branch manager, United Motors Service Inc., *Detroit.*

Mathison, Walter C., superintendent, Standard Motor Truck Co., *Detroit.*

Medvedeff, Nicholas J., assistant to the consulting engineer, Aeromarine-Klemm Corp., *Keyport, N. J.*

Mellowes, Alfred W., treasurer and general manager, National Lock Washer Co., *Milwaukee.*

Menton, S., production engineer, Chrysler Corp. of Canada, *Windsor, Ont., Canada.*

Montgomery, Donald H., treasurer and chief engineer, The Gridley Machine Co., *Hartford, Conn.*

Moore, Thomas B., president and treasurer, Detroit Ball Bearing Co., *Detroit.*

Morse, George, regional mechanic, The Texas Co., *San Francisco.*

Neafie, John H., New York City representative, Fate-Root-Heath Co., *Plymouth, Ohio.*

Nisley, John David, draftsman, detail, layout, Packard Motor Car Co., *Detroit.*

Ober, Roy, draftsman, International Harvester Co., *Springfield, Ohio.*

Oldacre, William H., factory manager, D. A. Stuart & Co., *Chicago.*

Pavlecka, Waldemar, aeronautic project engineer, Aircraft Development Corp., *Grosse Ile, Mich.*

Payne, A. O., chief engineer, Parks Aircraft, Inc., *St. Louis.*

Pearson, Geoffrey Harold, engineer, General Motors of Australia Proprietary, Ltd., *South Melbourne, Australia.*

Perkins, Harold G., assistant to general manager, Chrysler Corp., *Detroit.*

Petersen, Neil P., works manager, Canadian Acme Screw & Gear Ltd., *Toronto, Ont., Canada.*

Porter, Lemuel, foreman flat pattern department, Curtiss Aeroplane & Motor Co., *Garden City, N. Y.*

Pratt, Oliver Clinton, manager and owner, Motor Engineering Co., *Parkersburg, W. Va.*

Rasmussen, Theodore R., mechanic, M. J. Kane, *Seattle.*

Reppert, Clarence A., draftsman, jig and fixture designing department, Fokker Aircraft Corp. of America, *Glendale, W. Va.*

Rogers, Walter, 310 Athol Street, *San Francisco.*

Rohrbach, Adolf K., general manager and chief designer, Rohrbach Metallflugzeugbau Gesellschaft m.B.H., *Berlin, Germany.*

Rullison, E. A., engineer, Tillotson Mfg. Co., *Toledo.*

Russell, C. B., manager, Detroit office, Victor Mfg. & Gasket Co., *Chicago.*

Rutenberg, David, secretary and service manager, Manhattan Ignition Corp., *New York City.*

Scarth, William Monteith, engineer, specification department, chassis section, General Motors of Canada Ltd., *Oshawa, Ont., Canada.*

Schaefer, Raymond F., sales training course, The Buda Co., *Harvey, Ill.*

Schorman, William A. P., consulting engineer, The British American Oil Co. Ltd., *Toronto, Ont., Canada.*

Schreiber, Martin, general manager in charge of plant, Public Service Coordinated Transport, *Newark, N. J.*

Sickler, John Meharry, research assistant, Purdue Engineering Experiment Station, *West Lafayette, Ind.*

Sicklesteel, David T., chief engineer, Detroit Gear & Machine Co., *Detroit.*

Siewek, Otto H., sole owner, Siewek Tool & Die Co., *Detroit.*

Simms, J. Ward, factory service representative, Lathan & Co., *San Francisco.*

Sprung, Oren C., draftsman, Handy Governor Corp., *Detroit.*

Stahl, Lawrence C., salesman, Neafie & Fanning, *New York City.*

Stengel, J. Frank, director and manager automotive division, Dictograph Products Corp., *New York City.*

Stern, Bernhard, assistant to standards engineer, Chrysler Corp., *Detroit.*

Taylor, Archie, mechanic, International Motor Co., *Plainfield, N. J.*

Teetor, Don H., assistant sales manager, The Perfect Circle Co., *Hagerstown, Ind.*

Webb, Edmond F., electrical engineer, Chrysler Corp., *Detroit.*

Webb, Wallace George, engineer and works superintendent, E. G. Eagar & Son Ltd., Newstead, *Brisbane, Queensland, Australia.*

Welch, W. Hamlyn, laboratory engineer, Chrysler Corp., *Highland Park, Mich.*

Notes and Reviews

AIRCRAFT

Elements of Aviation. By Virginius Evans Clark. Published by The Ronald Press Co., New York City; 193 pp., illustrated. [A-1]

The author is a graduate of the United States Naval Academy, a pilot and aeronautical engineer, and has had a wide experience with the Army and Navy. Colonel Clark will also be remembered by members of this Society as Second Vice-President, representing aviation engineering, in 1922.

Many of the most successful airplanes built in this Country use airfoils designed by Colonel Clark, among them Colonel Lindbergh's Spirit of St. Louis, the Douglas airplanes used in the Army's round-the-world flight, and the best of the Army and Navy pursuit and training planes.

The book listed above is an answer to the need for an explanation of the principles of flight and a discussion of elementary design-considerations without resort to complex mathematics. Chapter X, a selected dictionary of aeronautical, physical, mathematical and mechanical terms, is a very useful and instructive feature.

Supplementing this volume, which deals with the principles of flight and the broader considerations of airplane structure and design, the author states his intention to produce another book of a more advanced character which will cover the practical problems encountered by the aircraft designer.

Rechnerische und Experimentelle Untersuchungen über Wärmebeherrschung und Leistungssteigerung in Luftgekühlten Flugmotorenzylindern. By Fritz Gosslau. Dissertation for degree of Doctor of Engineering, Berlin Technical University. Published by Julius Springer; 29 pp.; 31 illustrations. [A-1]

The progress of the air-cooled aircraft engine toward higher efficiency has been slow during the last 10 years, asserts the author. This retardation in development he attributes to the lack of any suitable method for calculating the thermodynamic requirements and stresses in such an engine. In his dissertation he sets forth such a method, which he has worked out and which can be used to supplement the well-known predictions of mechanical stress to arrive at a complete foreknowledge of the probable behavior of an air-cooled engine.

The heat loads are calculated from the major design data of the cylinder and the coefficient of heat transfer by a newly developed process. The calculated findings are then checked by the results of experiments on air-cooled engines.

Using the results of calculations and experiments as criteria, the author then passes in review various types of air-cooled cylinder, noting the effect on performance of different design features. He concludes that, for the highest cylinder efficiency, the engine speed must be reduced, and predicts that the future development will be along the lines of slow-speed, long-stroke, large-capacity engines.

These items, which are prepared by the Research Department, give brief descriptions of technical books and articles on automotive subjects. As a general rule, no attempt is made to give an exhaustive review, the purpose being to indicate what of special interest to the automotive industry has been published.

The letters and numbers in brackets following the titles classify the articles into the following divisions and subdivisions: *Divisions*—A, Aircraft; B, Body; C, Chassis Parts; D, Education; E, Engines; F, Highways; G, Material; H, Miscellaneous; I, Motorboat; J. Motorcoach; K, Motor-Truck; L, Passenger Car; M, Tractor. *Subdivisions*—1, Design and Research; 2, Maintenance and Service; 3, Miscellaneous; 4, Operation; 5, Production; 6, Sales.

Characteristics of Five Propellers in Flight. Report No. 292. By J. W. Crowley, Jr., and R. E. Mixson. Published by the National Advisory Committee for Aeronautics, City of Washington; 23 pp., illustrated. [A-1]

This investigation was made at Langley Field, Va., for the purpose of determining the characteristics of five full-scale propellers in flight. The equipment consisted of five propellers in conjunction with a VE-7 airplane and a Wright E-2 engine. The propellers were of the same diameter and aspect ratio. Four of them differed uniformly in thickness and pitch and the fifth propeller was identical with one of the other four with the exception of a change of the airfoil section. The propeller efficiencies measured in flight are found to be consistently lower than those obtained in model tests. It is probable that this is mainly a result of the higher tip-speeds used in the full-scale tests. The results show also that, because of differences in propeller deflections, it is difficult to obtain accurate comparisons of propeller characteristics. From this it is concluded that for accurate comparisons it is necessary to know the propeller pitch angles under actual operating conditions.

Aircraft Float Design. By Holden C. Richardson. Published by The Ronald Press Co., New York City; 111 pp., illustrated. [A-1]

This is another authoritative document dealing with aircraft fundamentals. Captain Richardson points out that the seaplane must embody both the factors that make for seaworthiness and those that make for airworthiness, and shows by an outline of these factors that in many instances the two are in conflict and require a compromise. The subject of design is treated from the viewpoint of form arrangement and proportion, and is carried into the determination of performance; the considerations affecting loading conditions are pointed out; and emphasis is placed on the usefulness and importance of model tests.

The author has felt it desirable to include the record of design features that have been tried and found unsatisfactory where these failures disclose little-known or novel phenomena of importance.

La Consécration de L'Autogire. By Henri Bouché. Published in *L'Aéronautique*, October, 1928. p. 338. [A-1]

A passenger on the Autogyro on its voyage across the English Channel, the author endows his story of the flight with the vividness and authenticity of a first-hand account. The chief technical interest centers in the descriptions of the manipulations of the pilot and the response of the craft in the three landings made. The descent of one of these was at an angle of 80 deg.; of the second, at an angle of 50 to 60 deg.; while in the third the more gradual incline of the ordinary airplane-landing was used. The author cites these to confirm his contention that the Autogyro can descend easily over a wide range of angles from the almost vertical down to the usual airplane inclination.

Meeting the criticisms of the Autogyro, the author explains why the inventor and pilot did not more frequently demonstrate the ability of his craft to make the almost vertical landing (87 deg.) which it has achieved in official flights, and discusses the contention that the rotating wings introduce a factor of danger because of liability of breakage through fatigue. His final impressions are summed up in his characterization of the Autogyro as the only radical technical innovation in heavier-than-air craft since the first flights were made, and as a machine

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